USABILITY EVALUATION MODEL FOR MOBILE E-BOOK APPLICATIONS

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By

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Abstrak

Penilaian untuk aplikasi e-buku mudah alih adalah terhad dan tidak menangani semua ukuran penting kebolehgunaan. Oleh itu, kajian ini bertujuan untuk mengenal pasti ciri yang mempengaruhi kepuasan pengguna terhadap kebolehgunaan aplikasi e-buku mudah alih. Lima ciri yang mempunyai kesan yang penting kepada kepuasan pengguna terhadap aplikasi e-buku mudah alih telah dikenal pasti iaitu pembacaan, keberkesanan, akses, kecekapan, dan pelayaran. Satu penilaian kebolehgunaan telah dijalankan ke atas tiga aplikasi e-buku mudah alih iaitu Adobe Acrobat Reader, Ebook Reader, dan Amazon Kindle. 30 pelajar dari Universiti Utara Malaysia telah menilai aplikasi e-buku mudah alih ini dan kepuasan mereka telah diukur dengan menggunakan soal selidik. Hasil kajian ini mendapati bahawa lima ciri tersebut (kebolehbacaan, keberkesanan, akses, kecekapan, dan navigasi) mempunyai hubungan positif yang signifikan dengan kepuasan pengguna. Ini memberikan pemahaman terhadap ciri utama yang meningkatkan kepuasan pengguna. Kajian ini juga telah membentuk senario tugas dan soal selidik kepuasan yang membantu dalam menilai aplikasi e-buku mudah alih.

Kata kunci: penilaian kebolehgunaan, kepuasan pengguna, aplikasi E-book.

Abstract

Evaluation for mobile e-book applications are limited and did not address all the important usability measurements. Hence, this study aimed to identify the characteristics that affect user satisfaction on the usability of mobile e-book applications. Five characteristics that have a significant effect on the user satisfaction of mobile e-book applications have been identified namely readability, effectiveness, accessibility, efficiency, and navigation. A usability evaluation was conducted on three mobile e-book applications namely Adobe Acrobat Reader, Ebook Reader, and Amazon Kindle. 30 students from Universiti Utara Malaysia evaluated the mobile e-book applications and their satisfaction was measured using questionnaire. The outcomes discovered that the five characteristics (i.e., readability, effectiveness, accessibility, efficiency, and navigation) have a significant positive relationship with user satisfaction. This provides insights into the main characteristics that increase user satisfaction. It also designed a task scenario and a satisfaction questionnaire which help in evaluating mobile e-book applications.

Keywords: Usability evaluation, User satisfaction, E-book applications.

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I ask Allah, the Greatest, to grant paradise to my dear mother in law, who passed away while we were away from our homeland, may Allah grant her Mercy and Forgiveness.

Finally, I present this humble work to all my friends those who are always asking Allah to grant me success, and those who are supporting me in different ways.

I want to say to all "Jazakom Allah Khairan".

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List of Abbreviations

B	Beta Coefficients
CPU	Central Processing Unit
DRM	digital rights management
EPUB	Electronic Publishing
EBONI	Electronic Books ON- screen Interface
E-book	Electronic Book
E-reader	Electronic Reader
F	Statistical Significance of the Model
HCI	Human Computer Interaction
IR	Information Retrival
IEEE	Institstute of Electrical and Electronic Engineers
ISO	International Organiztion for Standardization
iOS	iPhone Operating System
mGQM	Mobile Goal question Metric
NASA-TLX	National Aeronautics and Space Administration Task Load Index
PDF	Portable Document Format
PDA	Personal Digital Assistant
PACMAD	People At the Centre of Mobile Application Development
R^2	R-squared values
SPV	Subjects per Variable
SPSS	Statistical Package for Social Science
Sig	Significant
TOC	Table of Contents
UUM	Univirsti Utara Malaysia
UK	United kigdom
U.S	United States of America
UTAUT	Unified Theory of Acceptance and Use of Technology
VIF	Variance Inflation Factor

CHAPTER ONE
INTRODUCTION

1.1 Overview of the Research

The E-letter in the Electronic book is the novel word in the industry of publication (Rao, 2003). In the world of literature, the e-book is the most considerable development since the Gutenberg press (Siegenthaler, Wurtz, & Groner, 2010), and it is intended to transform the reading routine of many in the upcoming years (Subba Rao, 2003). On the one hand, due to that the e-book can successfully support the educational mission, it becomes a popular topic (Jeong, 2012). Furthermore, in the twenty-first-century reading is moving in the direction of e-format, which expected to become more common in the long run, and readers are exhibited to different electronic reading materials by using the e-book systems (ChanLin, 2013).

Nowadays, reading e-books is becoming popular; In U.S. the increasing in reading e-book among adults had been increased from 23% in 2013 to 28% in 2014, this increase has been influenced by the increasing number of adults who own e-readers devices or tablets (Zickuhr & Rainie, 2014). E-reading applications for non-dedicated devices, also becoming available from the most leading book retailers and multiple third-party developers, some are free and others premium paid. Examples of these applications are Amazon Kindle, Kobo eReader and Sony Reader (Wikipedia, 2015; Zickuhr & Rainie, 2014). With This technology the potential of publication growth becoming possible as the short time needs for publishing (Shin, 2011).

Currently, mobile devices' usefulness has been increased greatly in latest years, leading to performing more tasks in a mobile context (Harrison, Flood, & Duce, 2013). Mobile users are progressively more dependent on their communication and their lifestyle on mobile phones; As a result, these devices become important medium for essential services (Hussain & Ferneley, 2008). Subsequently, the mobile phone became another essential reading platform (Baron, 2015).

Many schools and universities have experimented with the use of e-textbooks as a replacement or alternative to traditional paper textbooks and more e-textbook reading applications and associated mobile apps have been developed by both textbook publishers and online book providers (Jardina & Chaparro, 2013, 2015). In addition, as there is increasing in the number of e-textbook published for education, there is also increasing in the number of students who used their mobile devices to access these applications (Rockinson- Szapkiw, Courduff, Carter, & Bennett, 2013).

Despite the increase in using the e-book, it still has some significant usability issues for reading in both recreational and academic. Since the readers are bothered and confused by copy write limitations on access, also they complain about the lack of high-quality tools for annotation and struggle to navigate the book (McKay et al., 2012). Furthermore, students highlighted frequently, but would often use outside materials (such as note cards, notepads, word processing document) instead of the annotation feature of the e-textbook. This has been shown to be true for a variety of devices for textbook access, including the iPod Touch and cell phone (Jardina & Chaparro, 2015).

McKay et al. (2012, p.1) stated that "it is a core principle of Human Computer Interaction (HCI) that interface, interface elements, and interface errors affect user behavior, this is demonstrably true in information seeking interfaces, as it is in other types of interface". It is also essential that the developers must carefully treat usability issues because bad usability decreases user productivity and, as a result, causes loss of users (Shitkova, Holler, Heide, Clever, & Becker, 2015).

The successful reading experience is the degree of understanding, reading at finest speed and finds it motivating. The most significant matter to discover is about the kinds of design factors that influence the reading in the e-book. These design factors include a device, user interface, and contents (Yi, Park, & Cho, 2011). Also, the consideration of a proper model and cognitive processes when evaluating these factors (Pearson, Buchanan, & Thimbleby, 2010; Yi et al., 2011).

This study adopted the evaluation characteristics and metrics used by previous e-book studies that did the evaluation in mobile devices. These characteristics are Readability, Effectiveness, Accessibility, Efficiency, and Navigation. The study assumed that there is a significant effect (positive relationship) of each characteristic on the user satisfaction. This means any increase in these variables will increase the user satisfaction of the e-book applications. Figure 1.1 illustrated the the theoretical framework.

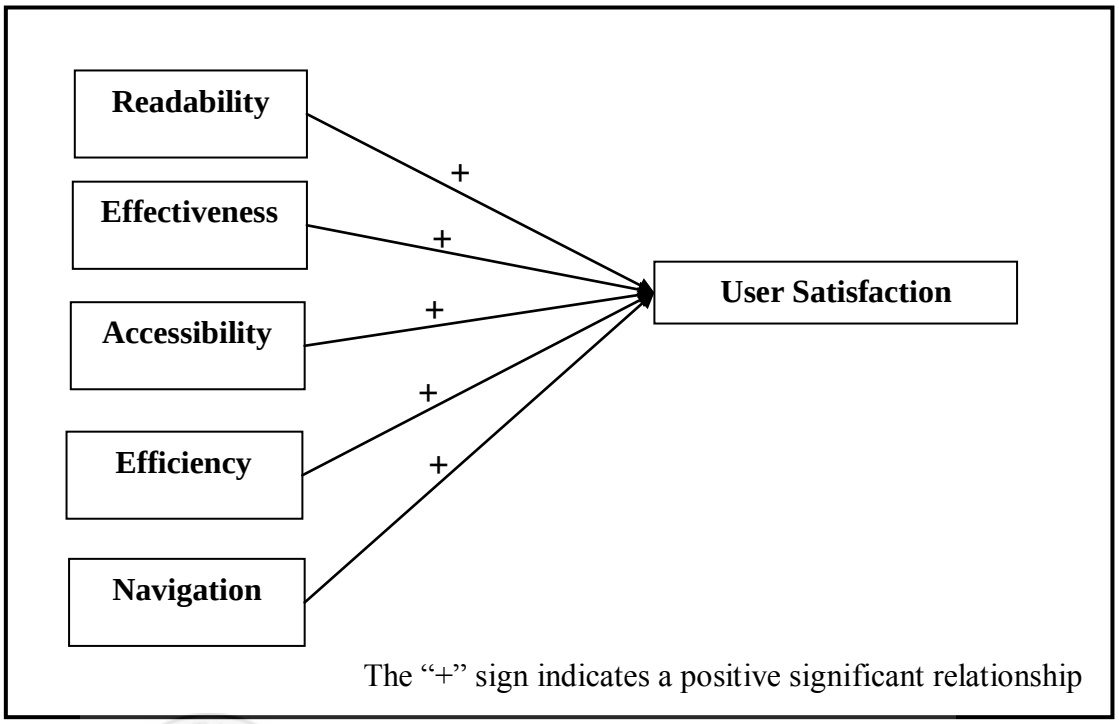

Figure 1.1. Theoretical Framework

This research proposes a model to evaluate the usability of mobile e-book application to address the limitations in the previous models (Refer to chapter two, section 2.8 for more details). In order to achieve the objectives, the study designed the research design as in Figure 1.2.

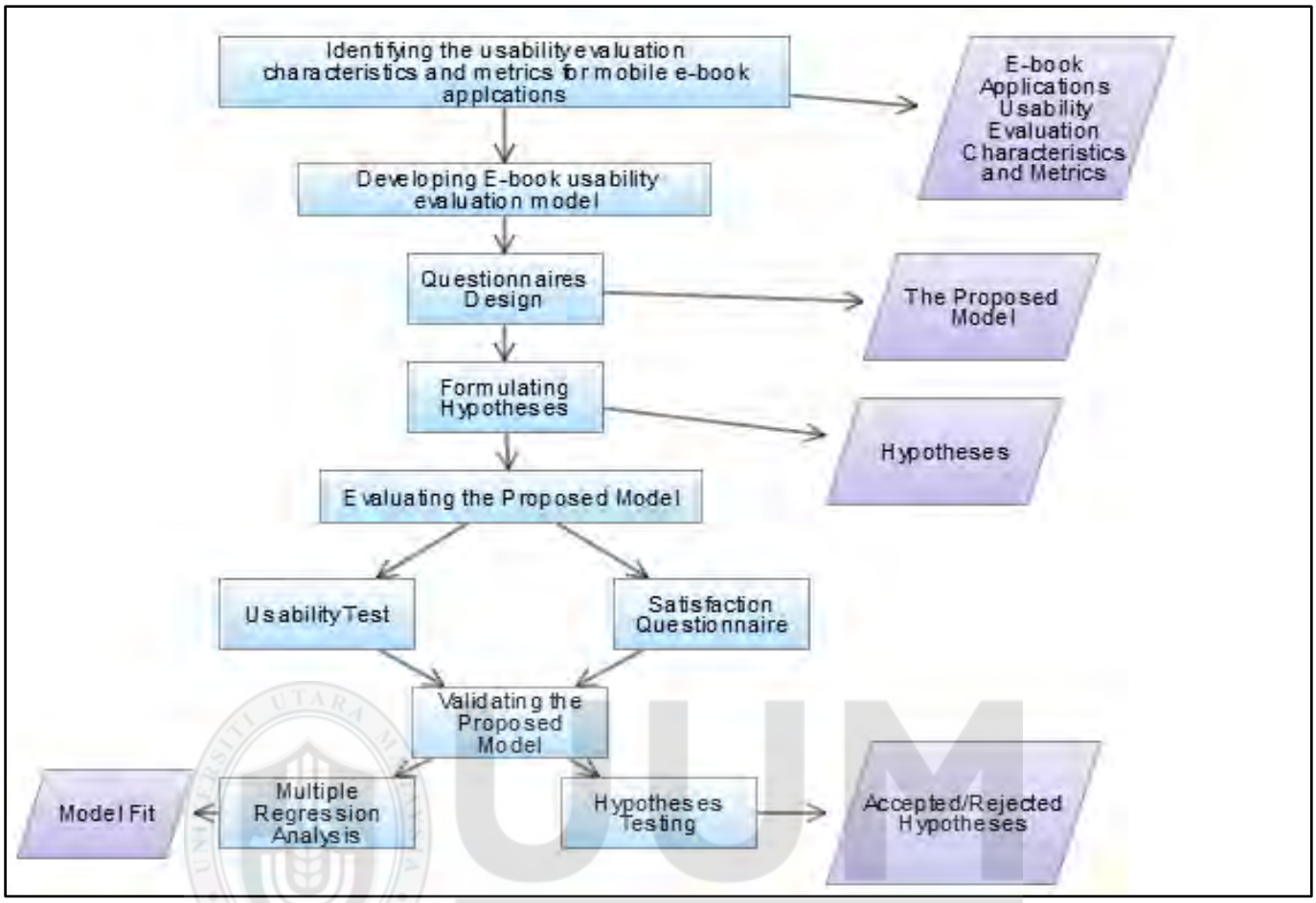

Figure 1.2. Research Design

1.2 Statement of Problem

Usability is a critical point to success or failure for any device, system, and application (Al-Saadi, Aljarrah, Alhashemi, & Hussain, 2015; Shitkova et al., 2015). The users are looking for applications that they can learn very easily, and can complete a particular task at an optimal time (Nayebi, Desharnais, & Abran, 2012). Nowadays, many mobile applications are ignored due to poor and not attractive user interface (Aktivia, Djatna, &

Nurhadryani, 2014). The mobile devices and applications have different usability issues from other computer systems, as they have different characteristics. For example, small screen sizes, different display resolution, connectivity issues, limited memory and battery, and limited data entry models (Nayebi et al., 2012). As there are many models used for mobile usability evaluation, almost all of these models are proposed for desktop application system and almost of them are outdated and need to be validated (Hussain & Kutar, 2012).

Currently, an extensive reading is done online in different screen sizes (PC, laptop, tablet, e-reader devices such as Kindle, cell phone) by using a variety of e-book applications. However, conventional books are slowly replaced by these devices and applications (Jardina & Chaparro, 2015). Though e-books are increasing in popularity, print books remain the basis reading lifestyle (Zickuhr & Rainie, 2014). This is true also for student reading as a survey conducted by (Baron, 2015). Baron and her group surveyed more than 300 college students in the U.S., Germany, Japan, and Slovakia, and the result showed a near-universal preference for reading in the print book, mainly for serious reading.

Presently, tablet computer and Smartphone ownership have each increased dramatically in recent years, and a growing share of Americans is using these multipurpose mobile devices rather than dedicated e-readers to read books (Perrin, 2016). Between 2011 and 2016, the number of Americans who read books on tablet computers has increased nearly fourfold (from 4% to 15%), while the share who read books on Smartphone have more than doubled (from 5% to 13%). The share of Americans who read books on

desktop or laptop computers has also increased, although by a more modest amount: 11% of Americans now do this, up from 7% in 2011. By contrast, 8% of Americans (Perrin, 2016). Figure 1.3 depicts the results in e-book reading by different devices among Americans.

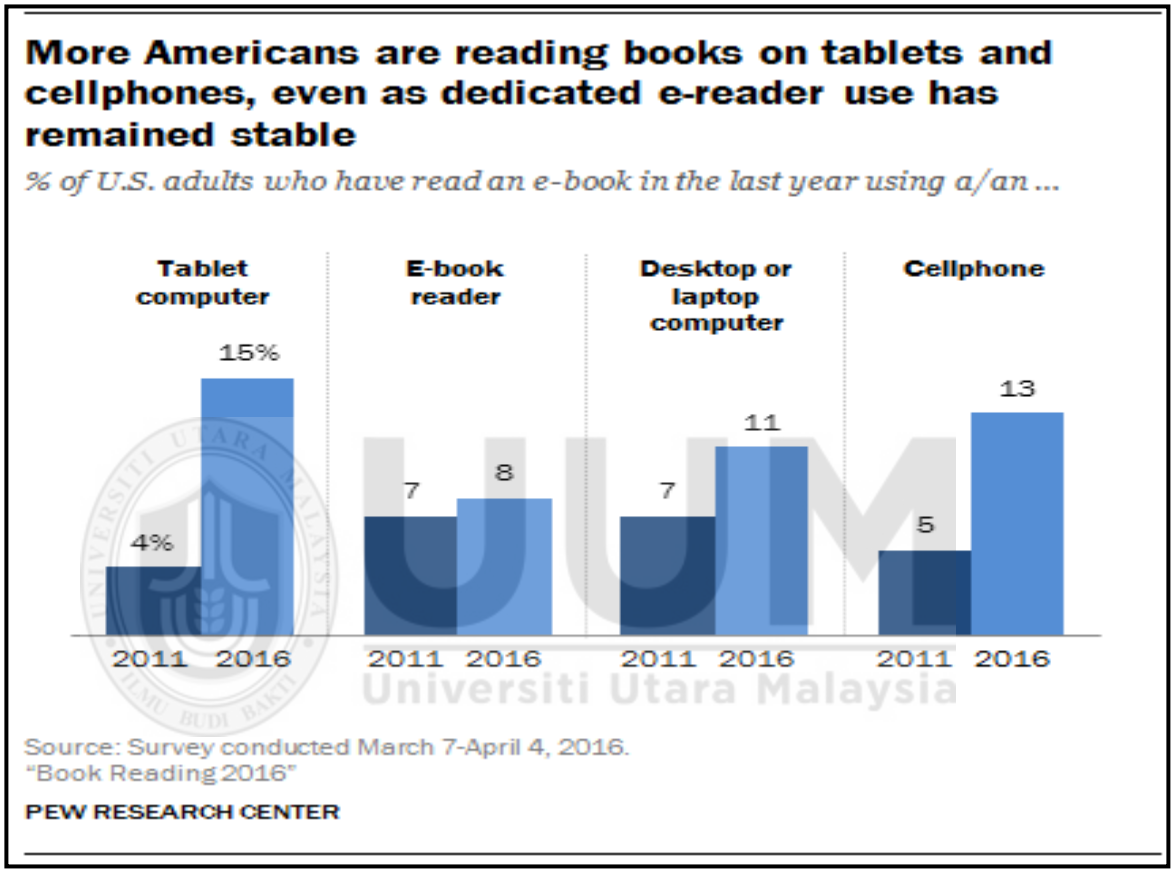

Figure 1.3. The Percentage of Reading E-Book in Different Devices (Perrin, 2016)

The usability of the interface in e-book and the features of its systems may impact on readers' interaction with reading content (ChanLin, 2013), and it is essential for user satisfaction in reading e-books to create an interface that allows a simple and quick access (da Silva & Dias, 2010). Jeong (2012) found that the readers have been disadvantaged by reduced legibility or interface issues while reading an e-book on screen. A study conducted by Mune & Agee (2015) reported about the lack of

supporting text-to-speech feature (Accessibility feature) by some platforms which have a tremendous potential to support reading by users with some vision disabilities.

Despite the fact that there are some proposals to standardise the e-book interface designs, which will illuminate the user need for repeating learning a new application interface efficiently, adherence to these guidelines does not appear (Colombo, Landoni, & Rubegni, 2014; Jardina & Chaparro, 2013,2015). Moreover, the guidelines that have been developed by Wilson and Landoni, more than ten years ago, were largely based on an evaluation of e-books on web pages and e-book readers that are aged and is not currently used due to the great improvements in the mobile technology (Colombo, Landoni, & Rubegni, 2014; Jardina & Chaparro, 2013,2015). On the other hand, reading text especially long text, and getting a good overview of the book contents still the main disadvantages of the e-book due to the lack of the navigation tools (Bligård & Berlin, 2015).

As a result of the increasing usage of mobile devices, e-textbook applications and related mobile apps have been developed by online book providers and publishers (i.e., Amazon, Apple, Barnes & Noble, Inkling, Chegg). Despite the features that some of these applications provided, many usability issues have been reported such as the complexity of navigating and using some features like search in effective ways (Jardina & Chaparro, 2015; Rockinson- Szapkiw et al., 2013). The previous two studies also reported about the increasing number of students who use their mobile devices as a reading platform, but they emphasised in more research in the usability of these devices before more adoption.

Therefore, this study is going to propose a model to evaluate the usability of mobile e-book applications because there are a few studies evaluated these applications especially by using mobile devices such as Smartphone. Furthermore, previous evaluation models are focused on evaluating one or two aspects of usability such as the readability and navigation or the accessibility of these applications. Previous studies also reported about some important characteristics that increase the usability such as readability (Jardina & Chaparro, 2015; Mune & Agee, 2015; Pearson et al., 2010; Richardson Jr & Mahmood, 2012), effectiveness (Pearson et al., 2010; Richardson Jr & Mahmood, 2012), but those studies did not measure the relationship and the effect statically. This study was hypothesised these relationships to identify the most relevant characteristics. The study was developed the model by reviewing the literature and compile the current measurements used for evaluating the usability of e-book application.

1.3 Research Questions

According to the problem statement, the following questions have been asked:

1. What are the current usability characteristics and metrics for mobile e-book applications?
2. How to design a usability evaluation model for mobile e-book applications?
3. How to evaluate the proposed model?

1.4 Research Objectives

The current objectives of this study are:

1. To identify the current usability characteristics and metrics for mobile e-books applications.
2. To develop usability evaluation model for mobile e-books applications.
3. To evaluate the proposed model.

1.5 Research Significance

This research has identified various points of significance. Study's results may be valuable to any developer, evaluator, and user of e-book applications.

Firstly, this research is vital to any e-book developers. It is essential to ensure that all developers are aware of the importance of following characteristics and metrics during the design phase. This is because implementing usability characteristics during the design phase will guarantee that certain types of errors are avoided. Subsequently, it will help in reducing the effort, and time needed for performing a particular development iterative, implement-evaluate-improve (Shitkova et al., 2015). Furthermore, the developer should be aware of treat usability issues because bad usability may decrease user productivity, which will cause loss of users (Shitkova et al., 2015).

Secondly, this research is crucial to e-book evaluators. The findings of this research will help evaluators to evaluate e-book application. It will help evaluators to ensure that the e-book application is usable, easy to learn, and satisfactory. Since general usability characteristics may address some area of usability, specific characteristics for the specific type of application will be very helpful to address certain usability issues.

Finally, once the e-book application has been designed and evaluated by following the characteristics and the recommendations from this study, the user interface will be more friendly, easy to use, and easy to learn. Users will be happier while using the e-book. For example, users can find the relevant tools that can help them in reading the e-book. They can also share their notes via their social networks and other application; this will facilitate them discussing their ideas very easily. In addition, users with print disabilities,

including dyslexia, impaired vision, or other issues, will benefit from the features that support reading for this group of readers. For example, provide features to change the size of the text to suit their needs, including audio book, and a text-to-speech feature.

1.6 Research Scope

This study focuses on studying the usability of mobile e-books applications on mobile devices (Smartphone) only from student's perspective. For this reason, the selection of the applications, platforms, and mobile devices is depending on the result of a pilot study (a survey that distributed to 98 students from Univirsti Utara Malaysia). See Appendix A. From the result of the survey; the study used three e-book applications available in the Google store. These applications are Adobe Acrobat Reader, Ebook reader, and Amazon Kindle. The study also chooses Smartphone devices and Android platform as the most widely used by the students. The participants in this study are students from UUM.

1.7 Report Organization

The report is divided into six chapters as the following:

The first chapter is introductory to the research problem statement, objectives, significant and scope. The second chapter is reviewing the previous work related to the current study to highlight what already done and discover the gap. The third chapter is about the methodology, the research design to achieve the study objectives. Chapter four is concerning about the model evaluation and the results of the regression analysis. In chapter five the usability test report is presented. Finally, the sixth chapter presented the study finding and reported the study contributions, limitations, and future works.

1.8 Chapter Summary

Chapter one gives an overview of the main research concepts. This chapter provides an overview of the study and discusses the statement of the problem that generates the research questions. Moreover, the chapter illustrates the research questions and objectives. It also clarifies the significant with respect to the scope of this study.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The previous chapter presents an introduction to the research by identifying the problem statement, the research questions, the objectives, and the significant of the study. This chapter contained the literature review, whereby the problem statement and the objectives were defined after reviewing the previous work have been done, and the related topic regarding the usability evaluation models and standards.

In fact, evaluation plays a significant role in software development. Firstly, evaluation is used to determine whether the user requirements are met. Secondly, it is adopted to assess the system's appropriateness for one task or a set of tasks. Thirdly, it is used to compare a system with other similar products on the market. The evaluation can be done as a formative evaluation throughout the development phase with the aim of improving a system iteratively till preferred design goals are met, and vulnerability of the system are removed. Otherwise, as a summative evaluation for the final design regarding standards, guidelines, or other evaluation objectives (Gediga, Hamborg, & Düntsch, 1999).

Usability is a central concept in software evaluation, usually it is comprehended as a quality characteristic that assesses the ease of using an application, as well as the methods that have been used to enhance easy usage through the design process (Hussain & Ferneley, 2008; Hussain & Kutar, 2009).

With the increasing in the development of mobile technologies, the number of mobile applications is increasing as well (Harrison et al., 2013; Shitkova et al., 2015). The vast and growing number of mobile applications in the market has required from the developers to build a high-quality application with the intention of competition. The quality of the application for mobile devices has several aspects. The important one is the usability, which now faces another challenge due to the portability of the mobile devices and their limitations (Flood, Harrison, Iacob, & Duce, 2013; Harrison et al., 2013; Hussain & Kutar, 2009; Nayebi et al., 2012). The usability guidelines with the evaluation methods designed for mobile applications should be studied specifically, this is because the characteristics and difficulties of developing such a mobile application. However, an evaluated and structured usability guidelines designed especially for applications used for mobile devices can seldom be found (Shitkova et al., 2015).

Many studies investigated the usage of e-book throughout the literature for both education purpose and leisure time such as (Jardina & Chaparro, 2013; Lewandowski, Co-investigator, & Lewandowski, 2003; Malama, Landoni, & Wilson, 2004; Maynard & Cheyne, 2005; P.Lam, S.Lam, J.Lam, & McNaught, 2009; Roskos, Brueck, & Widman, 2009), and despite the advantages of the e-book, many usability issues regarding the design of the interface have been reported. In Landoni (2010), the author stated that, while we have a consensus on the fact that high-quality design and only some studies provided suggestions and have been publishing guidelines for good practice; still a little consideration has been given to the impact of evaluation on the quality of e- book. It would really be very helpful for designers to experience a universal platform in words of

criteria, benchmarks, measures, approved procedures, and to judge the effect of the products on users but this really is away from incidence.

2.2 E-book Development Background

Michael S. Hart, a student at the University of Illinois, in the 1970s, launched the Gutenberg Project, archiving digitised versions of cultural documents. This is the earliest general e-books (Qian, 2011).

The idea of reading a book by using electronic devices is not new; it has existed since interactive began between end-user and computing devices (Siegenthaler et al., 2010).

All over the literature, e-books have been defined and described in several ways. These definitions reflect the development over time in e-book.Basically, an electronic book is just a series of bits, 1s and 0s which involve being programmed to be converted into meaningful words and sentences. It is about how to present these bits to creates a readable book, acceptable product (Wilson, 2002).E-book it is digital equivalent to a paper book that is a medium for communicating information, which includes facts, education materials, fiction, and discursive writing (Bennett & Landoni, 2005). E-book is a conversion of text or book into a digital form, or it is a digital reading material, or an electronic file consist of text and images and can be displayed on desktop, notebook, mobile devices, or dedicated devices (Subba Rao, 2003). E-book is a digital form of text, or a digital medium of reading, a computer-formatted book, or a digital file constructing from text and images (Lam et al., 2009). E-book is a regular book that had its medium changed, it is a book that is created without being published on paper, and it has to be read by electronic ways (da Silva & Dias, 2010). E-book is a digital file; originally, they

were plain .rtf, .txt, .doc, or .pdf files. Currently, they are implemented on reflowable formats, Mobi or ePub (Mana, Mich, De Angeli, & Druin, 2013). Nowadays, e-book not only simple textual file, but they also come in multiple formats, supports viewing multimedia such as audio, video, animated figure and interactive games or links to social networks such as Facebook or Twitter (Mana et al., 2013).

The term e-book is used to refer in different ways to hardware, software, and content (Wilson & Landoni, 2001). However, there is a need to separate the content and the platform in which the content is delivered, as well as separating the content from the technology used to access it (Gibson & Gibb, 2011).

Different kinds of audiences (such as kids, toddlers, and adults) have different kinds of reading requirements, thus leads to change the ways of presenting the print book to suit the readers needs even if the subject is same, this is also true for e-book (Bennett & Landoni, 2005).

Reading has become a foundation part of the human way of life, and it is a difficult human being activity, that has developed, and co-developed, with technology over the years (Pearson et al., 2010). The e-format of an e-book significantly reduces the costs associated with paper, distribution, printing, and recycling. E-books are cheaper, especially for the student, and do not involve physical space, allow for frequent updating of content, and may offer extra testing and learning opportunities (Yager, 2011). From previous researches, the features of e-book that make it more useful for readers, and influence their favourite over paper books were defined as the accessibility and functionality (Mune & Agee, 2015). Accessibility is the on-line and around-the-clock

availability of the e-book, and functionality is the functional features which improved e-book usability such as searching the content, annotations, and so on (Gibson & Gibb, 2011).

Libraries also turn into providing e-books. By providing this service to the patrons, libraries decreased the funds, narrow shelving space, solved persistent problems like lost or damaged or stolen books, save efforts by discard some processes like unpacking, shelving, and the routine process for handling and process the book before used. On the other hand, there are some reasons the encourage libraries to providing e-book. Firstly, the rising cost of replacing or repair a book, as well as the inter-library loan service. Secondly, the increasing demand for electronic resources especially from remote users (Roesnita & Zainab, 2013). However, good usability is required for satisfactory usage through these e-books, both devices and applications (Siegenthaler et al., 2010).

The attention for using electronic books in education have been generating for over a decade. In The history of Higher Education, the universities of U.S. have been tested different access models. E-books are also becoming more common in K-12 school libraries, with approximately half of school libraries in the U.S. offering electronic books in 2011 (Walton & Hailey, 2015).

The main drawback of e-books is on the complexity of reading the content on screens, even with the acceptable development in e-books, there is still a discussion about the particular impact of this reading style (Shin, 2011). Features like Poor readability, fundamental complexity, and bad design slow down the reading time because it

increases the reader's cognitive load due to the extra demanding on reader's concentration (Jeong, 2012). In addition, paper books behave consistently while digital interaction allows more variety and inconsistency, as well as the e-book, may turn out to be unreadable when changes occur in standards or licensing (Pearson et al., 2010). Furthermore, navigating throughout an e-book is one of the major complaints (Jeong, 2012).

2.3 The Visual Book and Web Book Experiment

The Visual Book experiment by Landoni (1997) examined the value of the visual element of the book metaphor for the creation of more efficient electronic books. A Visual Book is the product of the process of converting an existing paper book into electronic form using two main components, the Visual Book Builder and the Visual Book Browser (Crestani, Landoni, & Melucci, 2006). The core plan is to provide to the reader an electronic book similar as possible to the paper ones. This can be achieved by providing the essential physical features to the visual one such as the size and the quality. Also, by providing table of content, index, bookmarks, notes in the margins or elsewhere in the text, and highlighting of interesting parts. Moreover, facilitate the easy access to pages which are frequently consulted by following different visual clues, information about the ratio between the pages already read and those remaining, control of the reading progress, and browsing and scanning for interesting sections (Landoni, Wilson, & Gibb, 2000; Wilson, Landoni, & Gibb, 2002a).

The Visual Book experiment was conducted between 1993 and 1997 (Malama et al., 2004). Since then, users have become increasingly familiar with the Web and its

associated technologies (hypertext, browser interfaces, subject directories, search engines, and so on). Therefore, when today's reader approaches an electronic textbook, the second set of expectations inherited from the Web (in addition to expectations derived from using paper books) comes into play (Wilson, Landoni, & Gibb, 2003).

Although the Visual Book project revealed that the metaphor of the book is efficient when designing for visual e-books, the WEB Book experiment investigated the potential of increasing the usability of e-texts by changing the appearance of the content to fit the new medium. To do so, the guidelines to increase the scannability proposed by Morkes and Nielsen applied to electronic scientific textbook, led to increasing the usability by more than 92% (Landoni et al., 2000; Wilson et al., 2002a).

2.4 Electronic Books ON-screen Interface (EBONI) Project

EBONI by Wilson & Landoni (2001) was based on the previous work of the WEB Book experiments and the Visual Book by studying the significance of taking into account the user when designing e-books. The main goal of the project was to gather a set of top usability requirements for the publication of e-textbooks for the UK Higher Education community. This was achieved by the use of extensive evaluations involving more than 200 participants includes students, lecturers, and researchers with different disciplines and backgrounds (Wilson et al., 2002a). As a way to offer cohesion to the project, a common e-book assessment model has been created, from where every practice is going to be derived. This consists of numerous types of techniques including "low cognitive skill" and "high cognitive skill" tasks.

The first technique is measuring participant's skills to retrieve and remember information. The second technique is put by university teachers to measure student's perception of concepts from the questionnaires and texts intended to measure user satisfaction. Moreover, quite a few users are going to be filmed in the experiment among others will need to attend “think-aloud” procedures. Consequently, it will try to measure “usability” comprehensively as well as many different levels, incorporating traditional IR concepts and also user's satisfaction and lecturer's pedagogical objectives (Wilson & Landoni, 2001).

2.4.1 EBONI Methodology for Evaluating E-Books

Since the host of the book is changing, it is vital that the appearance of e-books be explored carefully, to ensure that commercial publishing improvements are sufficiently informed of the design, in addition to technology and content perspective, in order to provide to the end-user with high usability. From the project of EBONI, a general evaluation model was proposed, The methodology sets out choices for selecting participants, material, methods, and tasks which vary in complexity and depends on suitability to specific goals of the research and an availability of resources (Wilson & Landoni, 2001). This methodology is listed below:

i. Material Selection

In fact, electronic books offer different material collection for evaluation. The word “electronic book” is used all over proficient literature as well as culture to refer differently to software, hardware, and content (Wilson & Landoni, 2001). Generally, the e-book can be used to refer to hardware devices, E-book software, and Web books. In

the evaluation of e-book, the selection of text for comparison may be made according to the format/appearance, content, or medium.

ii. Actors Selection

E-book evaluations may differ in expressions of the skills and effort required to arrange an experiment. Generally, four main actors may be distinguished the participant, the evaluator, the task developer, the task assessor. The need to the assistance of task developer and task assessor depends on the type of the tasks applied in the experiment (Wilson et al., 2003; Wilson & Landoni, 2001).

iii. Tasks Selection

Some of the HCI methods are inherited to measure the interface usability. Some of these techniques and tasks are especially suitable for evaluating e-books for the purpose of gathering quantitative data regarding specific objectives of interacting with the e-book. Three forms of the task are explained to evaluate usability on different levels.

The first type is "Scavenger Hunt" which involves participants in searching through the entire selected material, for analysis of correct facts without any need to use the Find function. This technique used to observe how easy and fast the participants can find information in Web pages. In addition, it can be used for a special significance to e-textbooks, which are being utilized for retrieving information and facts regularly. The outcomes of the Scavenger Hunt will feed straight into two measures connected with usability the task time and task success.

The second type is memory Tasks. Memory tasks involve the participant reading a chapter or maybe a chunk of text for a short period, learning whenever possible in preparation to get a short exam. Morkes and Nielsen suggest these tasks as a method of testing a participant's ability to recognise and recall information from an electronic text, after spending a specified time from reading it. Data gathered by such tasks can often infer how the looks of information with screen affects users' ability to memorise that information.

The third one is high Cognitive Skill task. Scavenger Hunts and memory tasks entail participants in getting together with the text in a relatively straightforward manner, searching for information, or reading and trying to remember information. On the other hand, textbooks are often put to more complex and technical uses by students and lecturers, and high cognitive expertise tasks are intended to measure participants' ability to engage with the selected material inside a manner which takes a greater degree of cognitive skill. In this type of tasks, the roles of task developer and task assessor turn out to be a key. High cognitive skill tasks include the most costly with the types of tasks outlined here, primarily due to time and expertise necessary to develop and determine them. Because they are intended to reflect the educational requirements of individuals and teachers, at least, one lecturer in the relevant discipline is going to be heavily mixed up in the development of tasks that can elicit responses from participants that indicate their chance to use the text material critically (Wilson et al., 2003; Wilson & Landoni, 2001).

iv. Evaluation Techniques Selection

EBONI suggested these procedures for obtaining qualitative feedback regarding the selected material:

a) Subjective Satisfaction Questionnaire:

Satisfaction is measured once the participants manipulate the experiment material, and executed some tasks from the experiment; therefore, their acknowledgements are notified and based on practice. Researchers primarily focused on teaching and learning features of the research material (such as people using high cognitive skill tasks) could find it suitable to employ assistance from a lecturer in the proper discipline throughout devising the list of questions. He or she may be capable of giving recommendations, for instance, on items within an index calibrating participants' satisfaction with the educational components of the examination material.

b) Behaviour Observation:

This technique is acceptable for studies which are especially apprehensive with HCI concerns and can be utilized to study exactly how users interact with the test material in the evaluation of e-book. While think-aloud and interviewing discover details about participants' views, thoughts, and opinions; covert observation facilitates studying participants' physical behaviour and draws awareness about special problems. Using video as an observation tool will probably help the evaluator to discover more interaction problems that are difficult to be studied by another evaluation method and will, subsequently, give extra data to that derived from different evaluation methods.

c) Think-aloud:

This evaluation technique involves, at least, one participant and one evaluator for each participant, this procedure to allow the participants to explain what they are doing at each and every step of carrying out the tasks, and also why. This supplies qualitative information regarding the participant's cognitive procedures, descriptions of how they are navigating the test materials, and causes of problems. The evaluator can take notice of the participant's behaviour during the evaluation, which adds another way to obtain data. Performing this technique is more costly than covert observation and questionnaires with regards to space.

Sessions have need of noiseless environment, separate from additional participants in the assessment session. Think-aloud will be handled as the participant performed the tasks despite, as described above, they cannot simply be built-into a laboratory session with additional individuals present; consequently, they need to obtain another "time-slot" and so are relatively expensive. Furthermore, the occurrence is required by this technique of at least one evaluator for each think-aloud participant, as a way to document everything occurring through the session.

d) Interviews:

The interview as an evaluation method will be managed by a one-to-one foundation, subsequent any tasks. In this method, a "script" or list of clear instructions is used to cover a summary of questions in a fixed order. Nevertheless, the interviewer and respondent are absolved to follow leads. Patrick Dilley suggests structuring the actual flow of questions to be able to lead the conversation pointedly yet comprehensively

toward the bigger research questions of the learning. Even if the interviewer deviates from the script later, a printed list of questions serves as a guide to return. They are able to be used to generate full feedback on selected aspects of the experiment, and to check out leads on additional themes raised from the participant. Of all the evaluation techniques discussed within this methodology, interviews are essentially the most expensive. They will be conducted following your completion of tasks as well as questionnaires. Transcribing the interview later will probably be an additional cost. Interviews require the presence of no less than one evaluator for every participator, skilled in interview strategies.

The selection of these tasks and evaluation methods depends on the objectives of each evaluation of electronic textbook and the available resources. Moreover, the entirety cost of each test varied in term of the complexity of the tasks which are ranging from simple retrieval tasks to more complex high cognitive skill tasks. Moreover, the complexity of the evaluation technique, from inexpensive questionnaires to interviews requiring time and expertise (Wilson et al., 2003; Wilson & Landoni, 2001).

The different tasks and techniques, their measurements and their relationship to the criteria for evaluation are outlined in Table 2.1.

Table 2.1

The Evaluation Model Proposed in The EBONI Project (Wilson & Landoni, 2001)

Meta Criteria	Criteria	Measurement	Data collection methods/tasks	Type of data collected
Engagement	Satisfaction	Quality, Ease of use, Likability, User affect	Subjective satisfaction questionnaire	Quantitative and Qualitative
			Interview	Qualitative
	Memorability	Recognition and Recall	Exams	Quantitative
Directness (the ability to learn and internalise the interface)	Usability	Task success and Task time	Fact searching	Quantitative
			Think-aloud	Qualitative

It is clear from Table 2.1 that measuring the usability of the interface is depending only on two metrics, task success and task time. These two metric is not sufficient, whereby the simplest way to measure the usability can be achieved by using Single Usability Metric (SUM) which comprise four measurements task time, task completion rate, error counts , and satisfaction.

2.5 Electronic Book File Formats

There are two formats for e-books, page fidelity e-books such as PDF files, and reflowable digital e-book like EPUB, MOBI and IBA (Hailey, 2015; Mana et al., 2013; Rockinson-Szapkiw, Courduff, Carter, & Bennett, 2013). Table 2.2 summarises the e-book format characteristics.

Table 2.2

E-Book Formats

E-Book Format	Characteristics	Limitations	Examples	Source
Page fidelity (plain)	A scanned pictures of the printed book	Not support dynamic media and active links. Not capable to manage font and pictures.	.txt, .rtf, .doc, HTML or .pdf	(Hailey, 2015; Mana et al., 2013; Rockinson-Szapkiw et al., 2013)
Reflowable	Supports dynamic media, interactive features, and support many devices. Permit text to reflow and alter to any screen size. Enables changing the layout to suite the display medium	Some of these formats are proprietary, i.e. typically controlled by a company or organization. For instance, MOBI which is a proprietary format for Kindle e-readers, and IBA was developed by Apple which is especially used as iBook format	MOBI, EPUB, and IBA	(Hailey, 2015; Mana et al., 2013)

While the PDF format is the most popular format for academic reading, this format is rigid and does not permit text to reflow and alter to any screen size. Reading on small devices like mobile devices with PDF files need more effort from the reader (readers need to zoom in and drag to read the content). On the other hand, the reflowable format is suitable for mobile devices but almost digital library and databases for academic reading does not support this format.

2.6 E-book for Mobile

In the late 1960s, the earliest devices for e-reading were designed by Alan Kay, and later on presented in some generations of devices, for example, Apple Newton, the Amazon Kindle, and the Rocket eBook. These devices have been developed by innovations in technology (e.g., displays, CPUs, batteries) without considering the user needs. In 2000, great awareness and interest were started to read on dedicated e-reading devices. Various companies released dedicated e-readers (e.g., Hanlin, Franklin, Rocket eBook, Hiebook). Simultaneously, Microsoft developed software to read e-books in PCs called Adobe software and online shops for buying e-books were created (Siegenthaler et al., 2010).

E-books were usually planned to be read on dedicated e-readers, which have the advantages in term of portability, long battery life, and readability in bright sunlight (Shin, 2011); in 1998 e-book reader appeared with NuovoMedia's Rocket e-reader and Softbook. By 2000, Microsoft joined the market with its reader for Pocket PCs (Richardson Jr & Mahmood, 2012). However, any electronic device has a controllable viewing screen, such as computers, a PDA, and mobile devices like Smartphone and tablets can also be used. Figure 2.1 depicts the e-books reading devices.

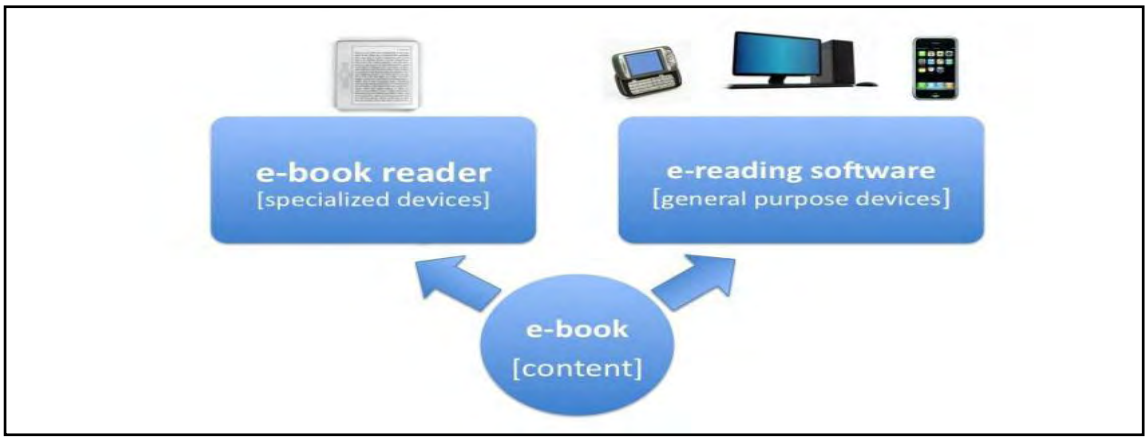

Figure 2.1. E-books Reading Devices (Siegenthaler et al., 2010)

Some dedicated e-readers apply e-ink technology which giving the electronic book a look same as the paper one (for example; Amazon Paperwhite) as well as reduce the power consumption which leads to increase the battery life and reduce the device weight (Siegenthaler et al., 2010). Other e-readers come with a complete colour touch screen features. This difference in the devices and applications provides elasticity to their users and permit them to read almost everywhere at any time and in different lighting levels and environments (Jardina & Chaparro, 2015).

The increase in using mobile devices leads to more usage of e-book applications, and related apps have been developed. Several of these applications offer many features to support reading, such as bookmarks, highlighting with different colours, the ability to make a handwritten note, and the ability to share over the social networks for notes and bookmarks. However, students ignore these features and choosing the cheapest option (Jardina & Chaparro, 2015). On the other hand, the user interface of these applications was varying while the content is the same. This requires the user to learn how to interact with each interface each time he uses new application. Despite the fact that there are

some proposals to standardise these interfaces design, which will illuminate the user need for repeating learning a new application interface, adherence to these guidelines does not appear. Moreover, the guidelines put by Wilson, Landoni, & Gibb (2002b) before more than ten years ago were largely based on the evaluation of web e-books and outdated e-book readers (Colombo et al., 2014; Jardina & Chaparro, 2015).

2.7 Usability Models and Standards

At the beginning of the twenty-first century, a major move has happened in the process of developing, designing and deploying computer software. With the significant increase in distributed systems, it is clear that the designer, technical personnel and guidance instructors do not have any direct communication with the end-user of their systems. The usability of software systems is not an extravagance work, but somewhat a simple factor helping in determining the productivity and the acceptance of software applications. Yet, without a certain understanding of the end-user of the systems, considering and achieving the usability and learnability of the system, becomes a significant quality obstacle for the designer (Abran, Khelifi, Suryn, & Seffah, 2003). Complex Computer systems are becoming an essential element in our daily living with a much wider consumer base, this has caused the usability to be more important and affects the way of designing the product from technology oriented to user oriented by understanding the interaction between the user and the product (Nayebi et al., 2012).

Usability studies have their root as early as the 1970's in the work of "software psychology" (Coursaris & Kim, 2006). Usability is usually comprehended as a quality characteristic that assesses the ease of using an application as well as the methods that

have been used to enhance the ease of use through the design process (Hussain & Ferneley, 2008; Hussain & Kutar, 2009).

Usability has been defined by IEEE Std. 610.12-1990 as "The ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component" (Abran et al., 2003).

ISO 9241 provides recommendations and requirements for hardware, software in addition to environment attributes, which supply to usability. The first two parts deal with general introduction and guidance. Part 6 concerning environment requirements. The Parts 3, 5, 7-9 deal with designing requirements and providing guidelines for hardware which can have some effects on software performance. Parts 10 to 17 treat the software characteristics. Figure 2.2 depict the 17 part of ISO 9241.

ISO/IEC 9241- 11 in 1998 describes the benefits from measuring the usability in expressions of user performance as well as satisfaction. They define usability as " the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" (Harrison et al., 2013; Seffah, Kececi, & Donyae, 2001); ISO 9241-11 proposes that measures of usability must cover:Effectiveness (the ability in which the users can accomplish tasks by using the system, and the quality that can come from the outputs after accomplishing those tasks). Efficiency (how much resources consumed within performing tasks). Satisfaction (users' subjective reactions when using the system).

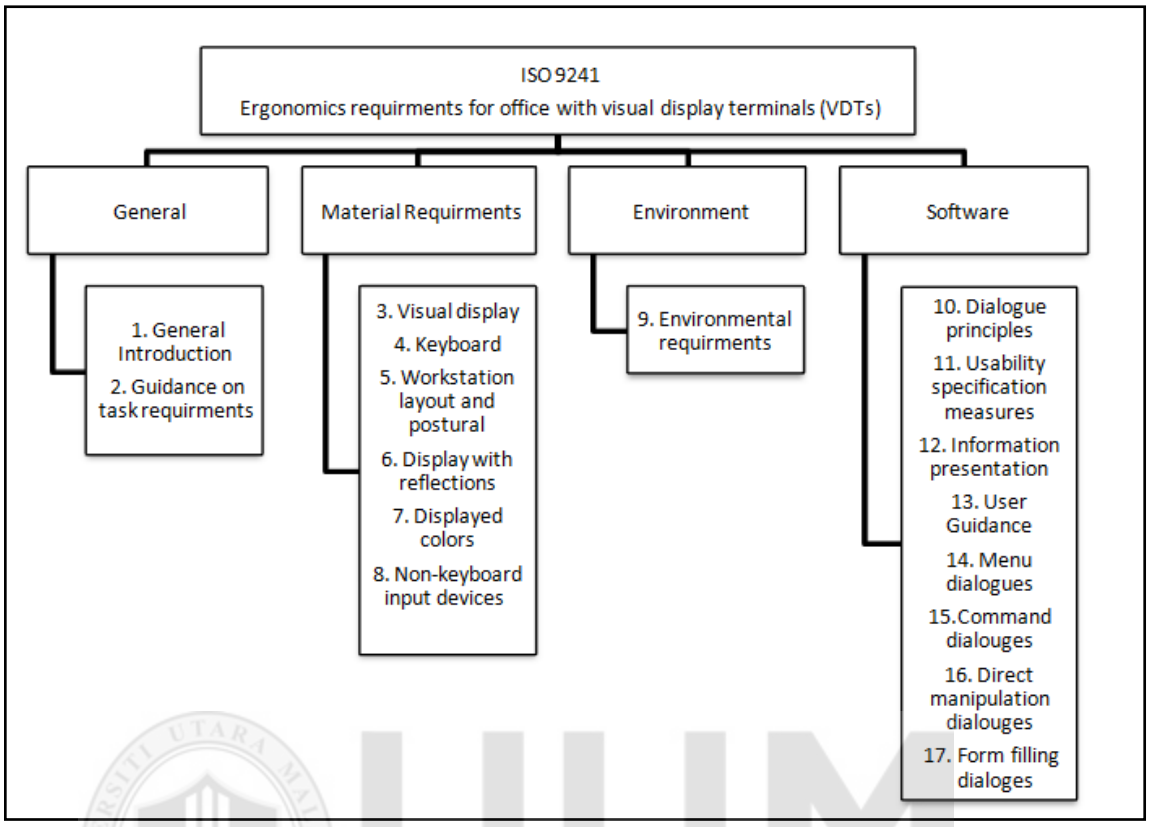

Figure 2.2. ISO 9241 (Abran et al., 2003)

ISO/IEC 9126-1 in 2001 introduces understandability, learnability, attractiveness, operatibility, and usability compliance with published style guides (Flood et al., 2013). The ISO/IEC 9126-4 in 2001 explained the detailed concept of quality in use as a sort of higher-order software quality feature that may be disintegrated into three factors, productivity, effectiveness, as well as security (Seffah, Donyaee, Kline, & Padda, 2006a). Figure 2.3 summarises the categories of ISO Standards associated with usability.

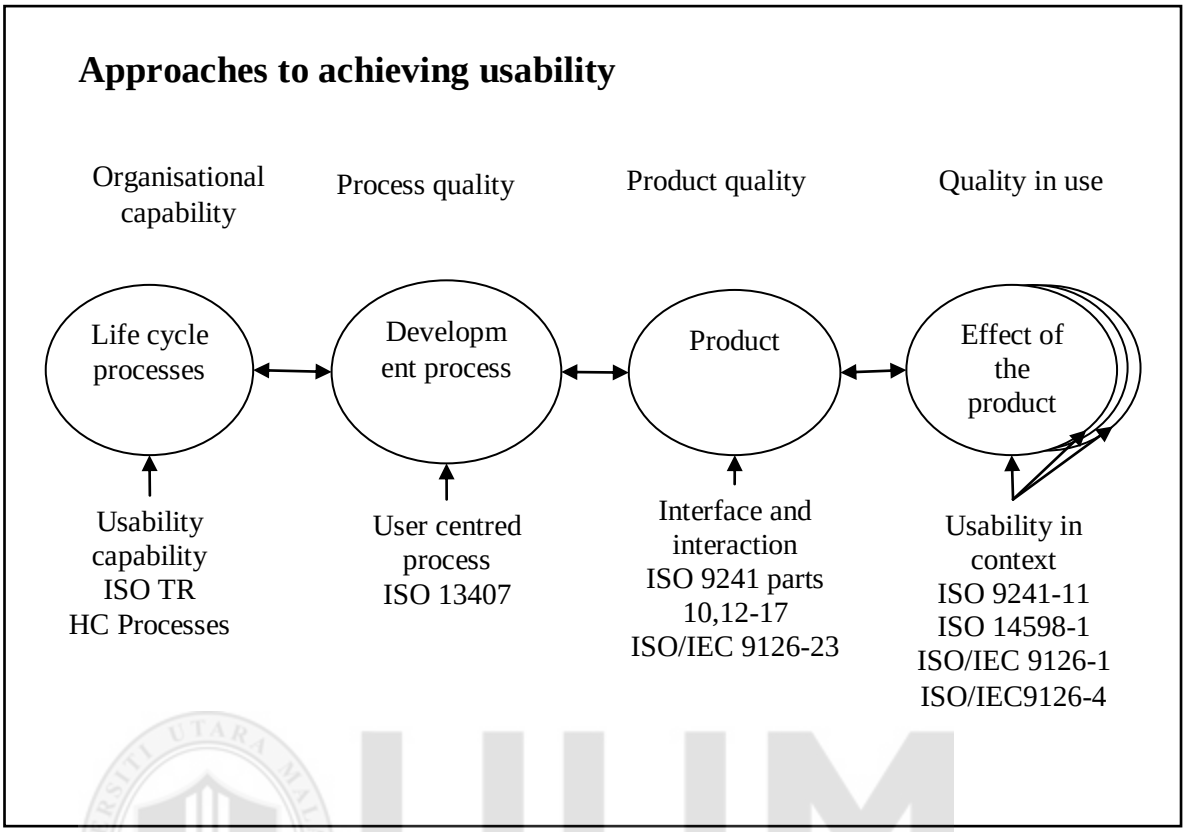

Figure 2.3. Usability Standard Categories (Bevan, 2000)

"ISO 9241-11" (1998) highlights three factors that the usability evaluation of the visual display terminal relies on them; the user, the goal, and the context of use. The user is the person who interacts with the system, the goal is the intended output, and the context of use includes the tasks, users, equipment. The equipment consists of hardware, computer software, and materials. In addition to the social and physical environments, that could all affect the ease of use of the product in the system. Measures of user satisfaction and performance evaluate the overall system of work. In addition, when a product is the centre of concern, these measures give details about that product usability from the specific context of use afforded by other systems (Harrison et al., 2013). Figure 2.4 depict ISO 9241-11.

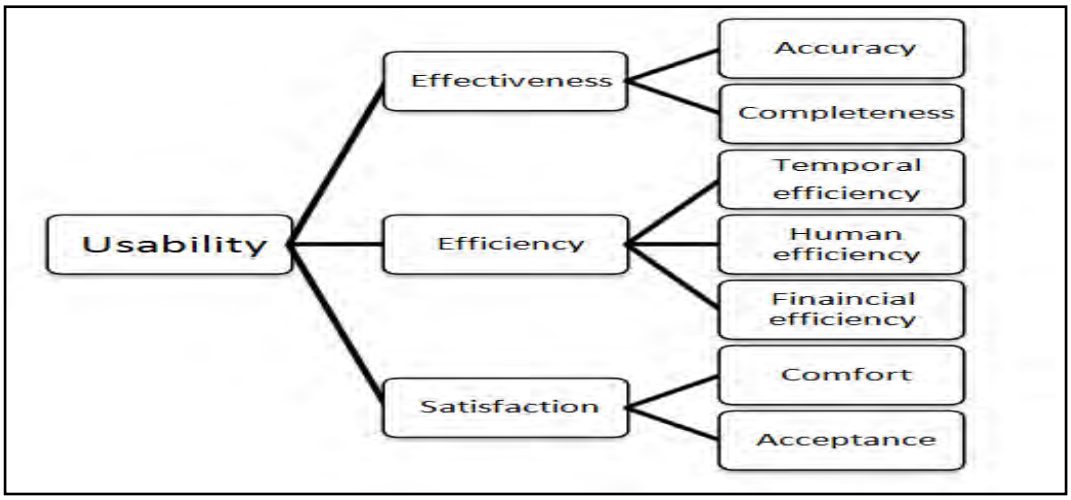

Figure 2.4. ISO 9241-11 Model for Usability (Nielsen, 1994)

Nielsen defined five attributes for usability (Harrison et al., 2013), Figure 2.5 depicts Nielsen model. First, Efficiency: Resources spent in relation to the completeness and accurateness with which users reach targets. Second, Satisfaction: freedom from discomfort, and positive emotions towards the product usability. Third, Learnability: the system must be uncomplicated when the user is starting learning so that he can speedily begin getting work made with the system. Fourth, Memorability: the system should be easy to remember so that the actual user is able to return to the system after some period and not having to learn everything all over again. Fifth, Error: the system must have a small error rate; users usually make few errors, and they can easily recover from these errors. Further, terrible errors must not occur.

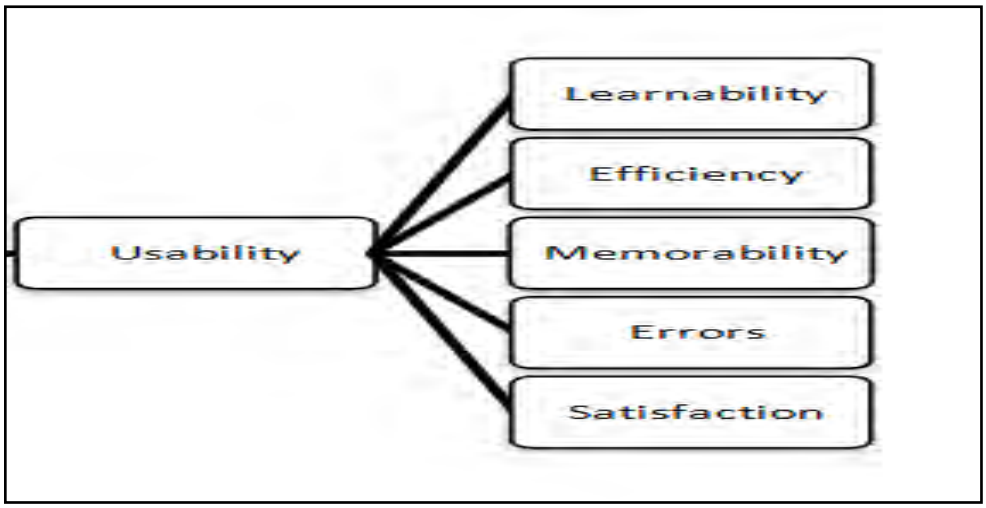

Figure 2.5. Nielsen Model for Usability (Nielsen, 1994)

A variety of usability models has been developed by the Human Computer Interaction (HCI) society. One weakness is they are not well incorporated into software engineering models (Seffah et al., 2006a). The typical limitations of those standards are that they are abstract and give hardly any indication of the best way to interpret scores of exact usability metrics (Flood et al., 2013). According to Seffah et al. (2001), a great quality-in-use model should define all of the characteristics that are required for a product to generally meet predefined usability goals for a particular context. Besides, the characteristics should include efficiency, learnability, satisfaction, and safety in addition to measurable attributes (metrics). Furthermore, a superior quality-in-use model should explicitly describe the relationships between the characteristics and these measurable attributes. Other requirements include decomposability, functionality, usability and automated support.

To answer the drawbacks of the previous models, the Metrics for Usability Standards in Computing model (MUSiC) was developed by Bevan & Maclead 1994. The model was

designed to give applicable and consistent means to specify and measure usability, while also providing problem-solving feedback which allows the design to be revised to advance usability (Flood et al., 2013). The model evaluates user performance in term of context-use, efficiency, productivity, effectiveness, satisfaction, learning, and cognitive workload (Flood et al., 2013), it includes specific usability metrics such as temporal efficiency, task effectiveness, and length of the productive period (Hussain & Kutar, 2009). Followed by MUSiC, the Software Usability Measurement Inventory (SUIM) was developed as a part of MUSiC, this model provides more measures of five usability area for global satisfaction, which are efficiency, effectiveness, control, learnability and helpfulness (Hussain & Ferneley, 2008; Hussain & Kutar, 2009).

Seffah et al. (2001) proposed a new model called The Quality in Use Integrated Map (QUIM) to specify and identify quality-in-use components; the model brings together different factors, criteria, metrics, and data that are defined in different HCI and Software Engineering (SE) models. QUIM can be used and seen as a framework to: reconcile the presented SE and HCI quality models especially those that concentrate on the usability; facilitate the requirement and measurement of quality-in-use in concurrence with the two other dimensions of software quality, developer, and manager perspectives; making usability more accessible by software engineers. QUIM in his first edition defined seven factors including effectiveness, efficiency, satisfaction, productivity, safety, internationability, and accessibility; twelve criteria and 100 metrics. The central of QUIM is the data which is required to calculate approximately metrics which may be qualitative or quantitative. This model has been expanded by Seffah et al. (2006) to include three addition factor namely: learnability, trustfulness, and usefulness;

in addition to twenty-six criteria and 127 metrics. Figure 2.6 depicts the hierarchy of QUIM model.

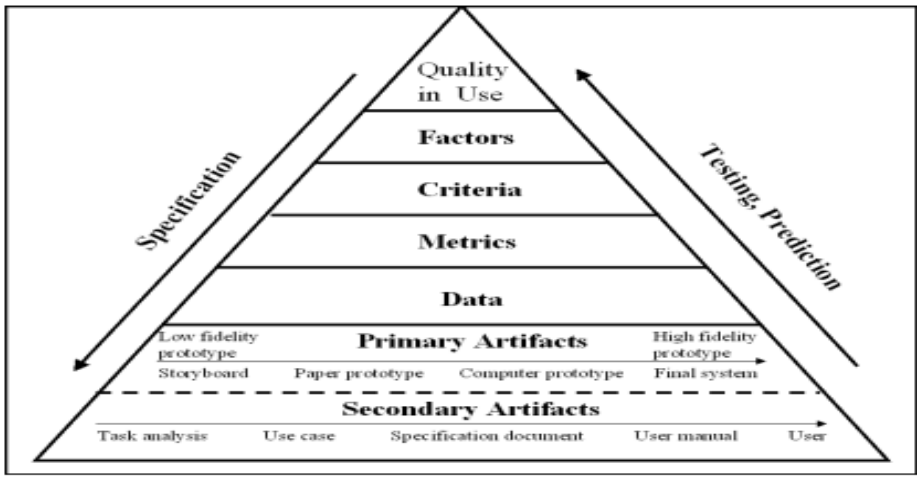

Figure 2.6. The Hierarchy of QUIM Model (Seffah et al., 2001)

Among other works and models includes the Skill Acquisition Network (SANe) which analysis the quality of using interactive devices, the semi-Automated Interface Designer and Evaluator (AIDE) which provided a software instrument to assess static HTML web pages depending on a set of guidelines which established in advance about Web page design. The Diagnostic Recorder for Usability Measurement (DRUM) is usually a software instrument with regard to examining user-based evaluations. In addition to examine the presentation of these data towards the proper party such as usability engineer. On the other hand, the Goals, Operators, Methods, and Selection rules (GOMS) model for the special task is made of explanations of the methods required to achieve defined goals using a software system (Hussain & Ferneley, 2008;Seffah et al., 2006).

2.7.1 Mobile Usability Models

Mobile device's usefulness has been increased greatly in latest years, leading to performing more tasks in the mobile context (Harrison et al., 2013). Nowadays, mobile users are progressively more dependent on their communication and their lifestyle on mobile phones, as a result, these devices becoming an important medium for essential services, such as news, weather, travel, and sports (Hussain & Ferneley, 2008).

Development in mobile technology facilitates developing a wide range of applications by the meaning of using on the move in the past few years (Harrison et al., 2013; Shitkova et al., 2015). The wide and growing number of mobile applications in the market has challenged developers to produce applications of higher quality intending competing. Whereby there are several viewpoints to the quality of mobile applications, the important one is usability (Nayebi et al., 2012; Shitkova et al., 2015). However, mobile devices encountered some limitations that hinder the usability of these applications (Flood et al., 2013; Harrison et al., 2013; Hussain & Kutar, 2009; Nayebi et al., 2012). Looije et al. (2007) and Wesson, Singh, & Van Tonder (2010) grouped these issues into three categories as in Table 2.3.

Table 2.3

Mobile Devices Limitations Categories

Category	Examples
Technical	Small screen size, limited connectivity, high power consumption, limited input method, limited memory, and varying display resolution
Environment	Temperature, noise, distraction, changing mobile context, cognitive constraint, and competition for concentration from other tasks
Social	Issues related to acceptance, privacy, adoption, personalization, and comfort

Simultaneously, the manufacturers of mobile devices have enforced another usability constraint. For instance, Apple iOS Human Interface Guidelines declares their platform features, that should be respected through the application development procedure, such as different resolutions, dealings with Multi-Touch screen, changing orientation, Gestures such as tap, pinch, and flick. Google as well, has developed Android user interface guidelines (Nayebi et al., 2012).

The usability of mobile devices and their applications varies from other computer systems, as they have different characteristics. Users are looking for applications that are easily learning, take the inconsiderable time to accomplish a particular task, and look to be easier (Nayebi et al., 2012). Many usability standards and guidelines have been developed in various areas and mobile devices applications as well (Hussain & Ferneley, 2008).

People At the Centre of Mobile Application Development (PACMAD) model was proposed by Harrison et al. (2013) to handle the limitation of current usability models with mobile devices. PACMAD includes significant attributes from some usability models as a way to create a more comprehensive model. It is based on two models, Nielsen and ISO, and address the limitation in both models in term of mobility of mobile application. Cognitive overload acts an essential role in the usability. This aspect of usability usually overlooked, since the previous models had been designed for importable software. Previous studies measured the usability in the basic attributes of ISO 9241-11. While other attributes like a cognitive load had been ignored, despite their potential impact on success or failure of an application. Recent researches have

confirmed that cognitive overload can be a crucial usability attribute. Mobile application's user has the potential to be affected by the cognitive overload in both his mobility and his interaction with the application. However, no particular guidelines were formulated in this study. Figure 2.7 depicts the PACMAD model.

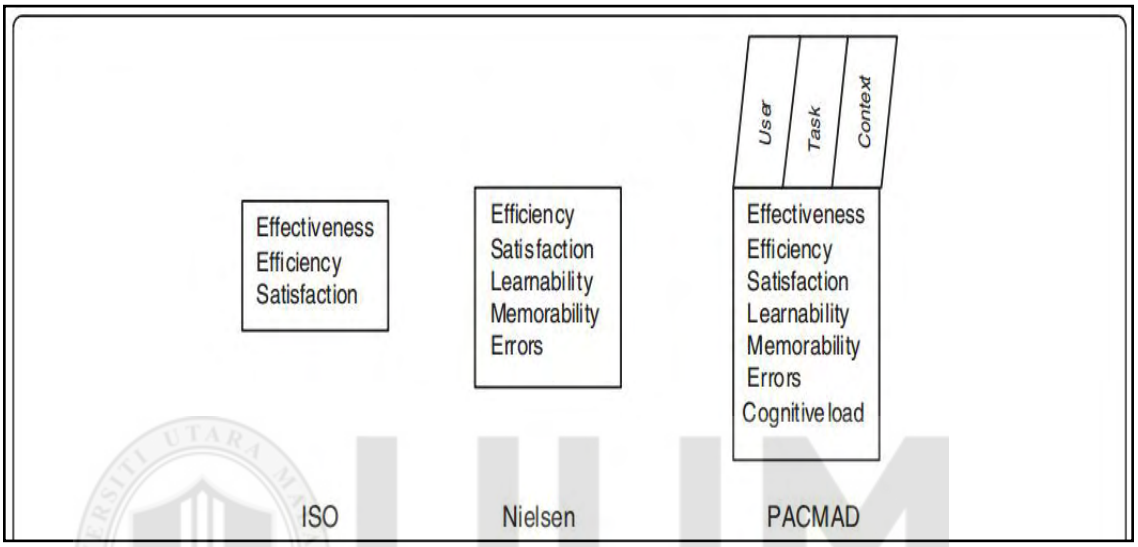

Figure 2.7. PACMAD Model (Harrison et al., 2013)

In (Hussain, Hashim, & Nordin, 2014) the authors propose a usability metrics for mobile applications based on the Goal Question Metrics approach which has been originally developed by Basili and Weiss and revision by Van Solingen & Berghout (1999). The mGQM (Mobile Goal Question Metrics) is a hierarchical structure; the general goal is defined, which refined to questions, and then metrics are created for each question. The model consists of usability metrics both subjective and objective, which aimed to assess both qualitative and quantitative measures for mobile applications respectively. Figure 2.8 depicts the complete mGQM model. The quality characteristics Efficiency, Effectiveness, and satisfaction are the main attributes used to derive the goals for the model, which are simplicity, accuracy, time taken, features, safety, and attractiveness.

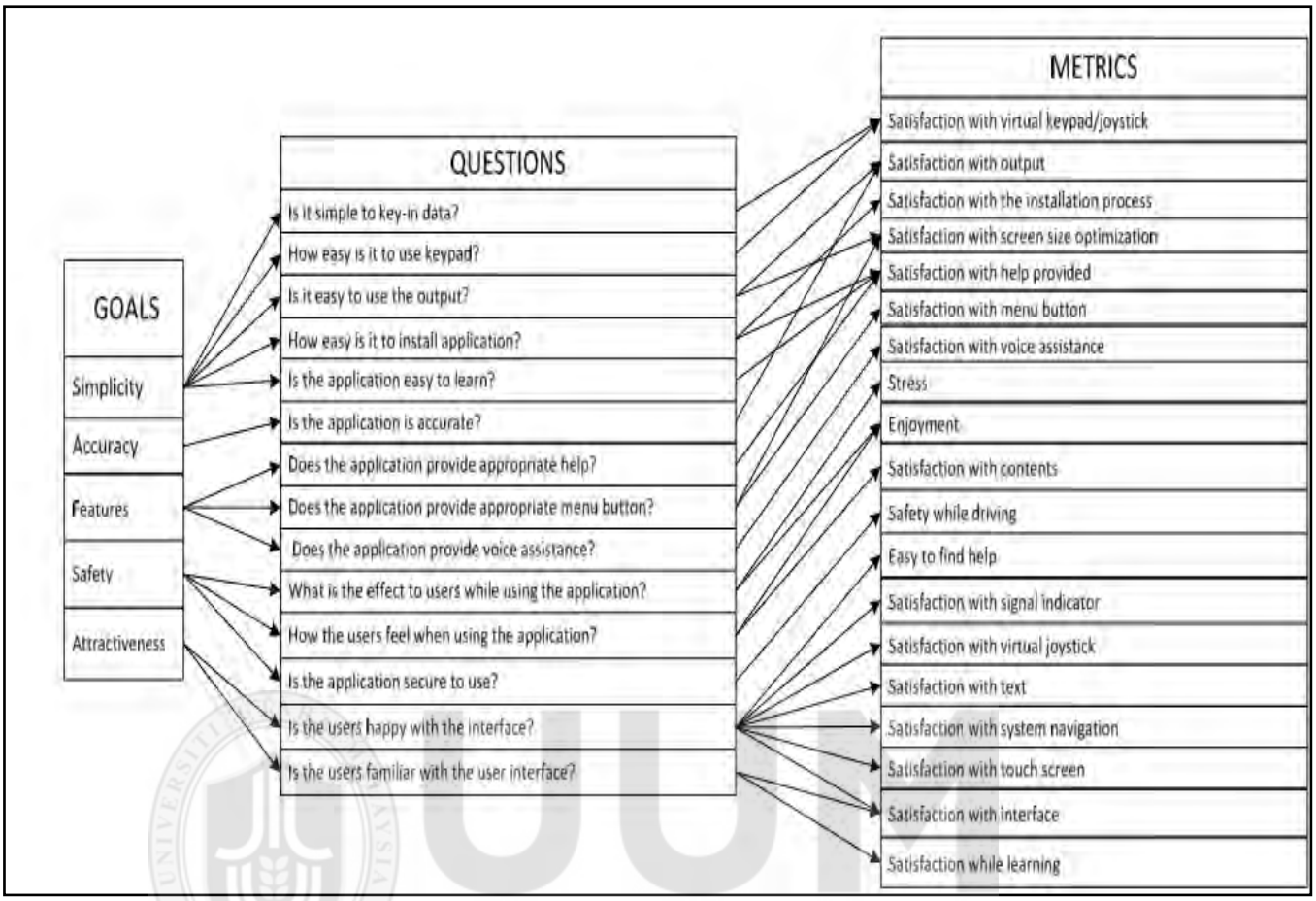

Figure 2.8. mGQM Model (Hussain, Kutar, Mutalib, & Kamal, 2012)

Other studies provided a set of guideline to design for better usability on the mobile environment like (Gong & Tarasewich, 2004; Warsi, 2011; Wessels, Purvis, & Rahman, 2011). Table 2.4 summarises and compares the different usability standards, models, and guidelines.

Testing mobile devices with real users is comparable to studies with normal computers, however requires special consideration for recording equipment, room setup, and even the test participants. Nielsen Norman Group illustrated these requirements as the following: first, Recording with an external camera is the preferred recording method,

either a webcam or a document camera and better to use both of them. Beside the camera, you will need some way to project it on a computer screen to allow the facilitator to follow the participant, but if the cameras come with their own video-recording software, you can depend on it. Second, regular user-testing lab will be nice, but is not necessary unless you plan to have many live observers.The testing Environment in which you set up your testing session needs to satisfy a few extra constraints to be suitable for mobile testing. For example, control the sources of light in the room, the brightness of the camera, device screen, and the monitor, and make sure that you have a good cellular signal in the testing room, as well as a high-speed wireless network available. Third, the test participants; unless you plan to study the learnability of a new device, they usually recommend that you recruit people who are familiar with their devices and have been using them for at least 3 months. New users often do not exhibit typical behavior, they may not know how to use their device yet, or they may not be familiar enough with conventions specific to the operating system (Budiu, 2014).

Table 2.4

Comparison of Different Usability Standards, Models, and Guidelines

Usability Standards, Models, Guidelines	Main Factors/ Guidelines	Comments	Domain
ISO/IEC 9241-11 (Standardization, 1998)	Effectiveness, Efficiency, And Satisfaction	These models are abstract and without any indication of the best way to measure the the main factors (should include metrics to measure these characteristics)	Software System
ISO/IEC 9126-1 (Iso & Std, 2001)	Understandability, Learnability, Attractiveness, Operatibility, And Usability Compliance		
ISO/IEC 9126-4 (Iso & Std, 2001)	Productivity, Effectiveness, And Security		
Nielsen model (Nielsen, 1994)	Learnability, Efficiency, Memorability, Errors, And Satisfaction		
MUSiC (Macleod, Bowden, Bevan, & Curson, 1997)	Efficiency, Productivity, Effectiveness, Satisfaction, Learning, Context-Use, and Cognitive Workload	These models addressed the limitations of the previous models and include specific usability metrics.	
SUMI (Kirakowski & Corbett, 1993)	Efficiency, Effectiveness, Control, Learnability and Helpfulness		
QUIM (Seffah, Donyaee, Kline, & Padda, 2006b)	Effectiveness, Efficiency, Satisfaction, Productivity, Safety, Internationability, Accessibility, Learnability, Trustfulness, and Usefulness		

Table 2.4 continued

PACMAD (Harrison et al., 2013)	Effectiveness ,Learnability, Efficiency, Memorability, Errors, Cognitive Workload, and Satisfaction	Lack of metrics to measure the usability for each factor	Mobile Environment
mGQM (Hussain, 2012)	Simplicity, Accuracy, Features, Safety, and Attractiveness	Included usability metrics	
Guidelines for mobile devices by (Gong & Tarasewich, 2004)	Design for (multiple and dynamic contexts, Small Devices, Limited and Split Attention, speed and recovery, "Top-Down" Interaction, Enjoyment), and Allow for personalization	Guidelines for the interface design of mobile devices and web interface in mobile	
Guidelines of web interface on mobile devices by (Wessels et al., 2011)	Minimize & Streamline, Scalability , Buttons and Hyperlinks, Content Overload vs. Content Depravity, and Consistency		
Seven Usability Guideline for Mobile Device by (Warsi, 2011)	Meet user's need quickly, Don't repeat the navigation on every page, Clearly distinguish selected items, Make user input as simple as possible, Only show essential information , Place basic browsing controls on the page, and Design mobile-friendly page layout		

While there are a lot of standards and models for evaluating usability, some of these models are abstract and did not come with metrics to measure the exact attribute. In addition, they are not incorporated into a particular theoretical and all of these models or standards do not explain the same operational definitions and measures.

Coursaris & Kim (2006, 2011) performed a qualitative review of 45 empirical mobile usability studies in 2006, followed by 100 empirical mobile usability studies in 2011, their aim is for addressing the key evaluation dimensions for mobile usability studies. They found that the core dimensions for the measurement of usability in those studies are; efficiency, effectiveness, and satisfaction, which reflects the ISO 9241-11. As a result, this finding gives a sturdy container for its use in related upcoming studies.

Usability guidelines which can be used to ensure some sufficiency of an exacting user interface are an example of one method for maintaining usability awareness, which is imperative for improving usable and useful software (Shitkova et al., 2015). In the design phase, implementing usability guidelines can reduce effort and time required for completing the particular development iterative "implement-evaluate-improve" steps by guarantee that some types of errors are prevented. Moreover, the characteristics and difficulties of developing mobile applications required that the usability guidelines and the methods of evaluation to be studied carefully for the mobile applications (Shitkova et al., 2015).

2.7.2 Usability Evaluation Methods for Mobile

Usability evaluation for immobile computers systems has developed to be a conventional discipline within HCI. Discussions are still ongoing, but the all based on a shared comprehension of fundamental ideas. Both field and laboratory approaches are important and accepted by the majority of literature, and many scholars have provided utilising methods and techniques of evaluation and empirically reported experience (Kjeldskov & Stage, 2004).

Established concepts, approaches, and methodologies in HCI have been examined with the increasing demand of using a handheld, wearable, and mobile computing devices systems. This formed a need for a new design and evaluating approaches to ensure their usefulness and usability (Duh, Tan, & Chen, 2006). Mobile systems are usually employed in remarkably dynamic contexts. In addition, their use usually requires many people distributed within the user's physical environment. Consequently, field-based evaluations look like an appealing approach for evaluating mobile applications usability. However, evaluating usability within the field is not easy (Duh et al., 2006).

Three crucial issues are stated within the literature. Firstly, it might be very complex to set realistic studies of which capturing extraordinary situations within the use-context described proceeding. Secondly, it is essential in a field study evaluations to implement established evaluation techniques including think-aloud and observation. Thirdly, in the field study evaluations, the collection of data is tough because the users are moving and there is no control over them (Kjeldskov & Stage, 2004). These types of difficulties are appreciably reduced in a laboratory context. When usability assessments are conducted

in a laboratory, experimental control, and high-quality data are not a concern. However, one of the disadvantages of a laboratory setting is having less realism. Current ways of laboratory-based usability assessments of stable desktops attempt to solve this issue by recreating or simulating the original context of easy use in the lab via means of, for instance, furnishing it just as one office. Nevertheless, when we evaluate mobile devices in a laboratory setting, the user mobility along with the activities is usually very hard to recreate realistically (Kjeldskov & Stage, 2004). Evaluation regarding mobile applications usability is frequently being reported. A recent review of mobile HCI research has revealed that laboratory studies are presently by far the most accepted method intended for evaluating mobile devices (Kjeldskov & Stage, 2004; Nayebi et al., 2012)

2.8 Usability Evaluation Models for Mobile E-Book

The user's wants and needs of the look and feel of the book are paramount (Wilson, 2002). As Nielsen states in (Wilson, 2002),that there is a need for some user testing to evaluate the interface because users have an open potential for describing the design of the interface in new and surprising ways. For sure, the requirements will be different according to the nature of the book being tested. The strategies used to read books are different, whereas novels are reading in sequence, from cover to cover, textbooks have a tendency to be consulted, scanned and skimmed in a random manner. In contrast, encyclopedias have facts concerning varied subjects and are used to refer to many purposes; once more, their users may have another pair of requirements. Audience clarity is, for that reason, the first stair in evaluating the “usability” of an e-book (Wilson, 2002).

Landoni (2010, p.1) states that:

> "While there is a consensus on the importance of good design and few authors have already been publishing guidelines and provided advice on good practice, still not much attention has been paid to evaluation and its impact on e-book quality. It would indeed be extremely useful for designers to have a common platform in terms of benchmarks, agreed procedures, criteria, and measures to evaluate the impact of their products on users but this is far from happening".

Addressing usability for the e-book is necessary as interactive systems have to be designed by considering the user needs. Evaluating usability requires analysing if the systems are efficient, effective, secure, learnable, memorable, and have a real utility (Lewandowski et al., 2003).

Bligård & Berlin (2015) and Faculty, Moore, & Fulfillment (2014) studied the effects of using e-books in education. They examined whether e-books can replace the traditional paper book. Despite the advantages of e-book reported by both studies, students find it harder to read on a computer/tablet screen and harder to get an overview of the content compared to paper books.

Another study in users' acceptance behaviour by Gao & Deng (2012) used UTAUT to mine the influence factors which hinder active development on e-books, and extract the ways to enhance the efficient service of this novelty product. Their findings show that a

great promoting in the development of e-books in mobile marketing can be achieving with high-quality content, media promotion, and user-friendly interface.

Wilson et al. (2002b) defined guidelines for designing an electronic book, these guidelines are the outcomes from the Web Book experiments, the visual Book, and the EBONI project (Landoni et al., 2000; Wilson & Landoni, 2001). Two essential styles emerged as standard to the e-book ease of use in requisites of their on-screen style: a) The paper book inheritance metaphor, and the insight of adhering with this, where suitable, in the setting up the e-book; b) User associating with new medium bringing another collection of requirements. These sorts of themes, together with facets of hardware design and style, were investigated through the EBONI Project in some e-book evaluations with the results establish an assortment of Electronic Textbook Design Guidelines.

The guidelines regarding the design of the interface include: Including a table of contents (TOC), which helps in easily navigate the book's chapters and main headings. TOC must be direct and clear, and users can access to it from all pages, as well as a hypertext TOC which links to specific pages. Including an Index, which is dynamic, prominent, easy to find, and clear to users. Provide orientation clues; provide the number of page with a navigation bar which highlights the current position of reading with accuracy and visibility, and supporting of jump to specified pages. Provide bookmark and annotations functions: which are powerful and easy to use, users can search over them, and can share them with another application. Provide a search function with intelligent capabilities with search tips is important to quick search. Use hypertext to boost navigation and assist cross-referencing. Provide back and forward. Standardize the

colour of links to those using in web pages. Enable customization; users can change font style, size, and colour as well as save the preferred setting. These guidelines are very helpful and almost all studies depending on the outcomes from this experience to evaluate the e-book.

To set up design guidelines for e-readers, Pearson et al. (2010) conducted a study to evaluate and find out the usability problems of the interface of the e-readers using HCI principles by heuristic evaluation. The research was carried out using three e-readers with the same (e-Ink technology, resolution, and screen size). These readers are Sony PRS 600, Kindle 2, and Sony PRS 300. Only Sony PRS 600 was a mixture of touch and button device whereas the other two were button devices.

This study evaluated the three devices based on HCI guidelines, which are: metaphor, light-weight, ergonomics, completeness, and active reading functions such as bookmarks, annotation, page turning, and magnification. Metaphor, light-weight, consistency, and ergonomics guidelines are related to the design and functionality of the hardware, not to the software interface, which is out of the scope of this research.

The Guidelines and metrics used to measures the software (application) included: First, Completeness; the bookmarks can be easily seen on a separate page, users can found the bookmarks without browsing the entire book. Different types of bookmarks must be available such as one made especially for bookmarking the last page in reading for quick reference. Bookmarks can easily be organised and deleted. Second, Active reading functions which supporting of active reading features such as bookmarking, annotation, page turning, and magnification.

This study is significant, the study address two important characteristics completeness (According to Seffah, Kececi, & Donyae (2001), the criterion Completeness affects the characteristic Effectiveness) and readability (active learning functions). However, the study omitted other important characteristics such as Accessibility. This study used only heuristic evaluation as a method of evaluation whereby more accurate results can be addressed by using real users.

Studies like (Colombo & Landoni, 2011; Elliott, 2003; Gibson & Gibb, 2011; Mekonnen, 2014; Patel & Morreale, n.d.; Wilson et al., 2002b; Yi et al., 2011) illustrated that readability increase user satisfaction.

The web technologies are used increasingly, and different e-book platforms support interactive functions, for example, hyperlinks, editing tools, annotations, and search tools. These functions are a bonus that e-books contain more than print books. Nevertheless, preventative should be used in the design of functions. Since users are very knowledgeable about online tools, including the Google search tool, they may become confused and frustrated when e-books do not act equally (ChanLin, 2013). Wilson, Landoni, & Gibb (2003) found that users exhibited specific predetermined expectations, based on their online experiences, about how those tools of e-book should operate.

From this, we can argue that the characteristics Readability and Effectiveness are affecting user satisfaction on the usability of e-book application. These two

characteristics were used for constructing the first and the second hypotheses in this study (Hypothesis H1, H2).

Siegenthaler et al. (2010) studied five e-readers to investigate these e-readers in term of legibility and usability. This study used ISO 9241-11 (Efficiency, Effectiveness, Satisfaction). They observed that the supposed legibility of the text was equivalent to a paper book upon the first experience. Nevertheless, after practice, participants assessed the supposed legibility based on their user practice instead of on their efficiency differentially. In order to evaluate the usability, participants were asked to perform five tasks. After that, they evaluate these e-book readers in term of design, navigation, orientation, functionality, and handiness. Users experienced dissatisfaction whilst interacting with a number of the e-readers which damaged their post-judgment and satisfaction.

This study shows that changing font size is an essential feature, especially for old people and those have some vision problems. Changing the font size will increase the group of the readers of e-books which mean will increase the e-book accessibility. The results of this study also showed a notable insufficiency in the usability of the current e-reader generation. It is clear from the number of tasks (only five) in this study that the user did not evaluate the given material with a sufficient time. More tasks can provide more real judgment of the usability.

It is also reported by other studies like (Agee, Mune, & Gonzalez, 2015; Biancarosa & Griffiths, 2012; Mune & Agee, 2015) that the ability to change font size, supporting the

audio book, and support text-to-speech will increase the Accessibility of e-book by users with a vision disability. As a result, it will increase the usability.

From this, we can argue that the factors Accessibility and Efficiency are affecting user satisfaction on the usability of e-book application. These two characteristics were used to construct the third and fourth hypotheses in this study (Hypothesis H3, H4).

Richardson Jr & Mahmood (2012) studied the usability and satisfaction from a user perspective of five e-readers; Barnes & Noble's Nook BNRV100; the Amazon Kindle; the Apple iPad MB292LL/A; Sony Digital Reader PRs-950; and Borders' kobo reader N647-BUS-S. The study depended on a survey involving 81 graduate students who owned an e-reader, their perceived issues, and what they like and disliked. In addition, interested respondents had been requested to volunteer to have an ethnographic journaling research which permitted eight users to reside with each one of the selected five readers for at least two days. The study found that the most famous e-reader is the Kindle, but the respondents did not like the bad navigation and the lack of ability to loan their collection to their friends. Furthermore, the respondents preferred the portability of the readers and the facility to own many books using one device. Nevertheless, they as well recognised the main issue: the licensing of titles against a complete purchase. In contradiction to other published papers, the respondents would not value the support of non-Roman script or coloration display. They also emphasise in the important of that the e-book must be a source of a new edition of publications or at least republication of previous editions. Furthermore, the e-book must be easy to read, quote, and search, legible within low light conditions, offering random access to the content instead of

scrolling, the ability to take note or highlighting, the ability of downloading books, and providing a dictionary accessible at one's fingertip.

This study consisted of some metrics using to measures how easy to perform tasks in e-book as well as how can users share their titles. These features can be considered as supplementary to Effectiveness whereby users can perform tasks as easy as he can do with the print book. Metric like support dictionary is an important measurement to increase Readability (Rao, 2003; Roskos et al., 2009; Thayer et al., 2011).

Jardina & Chaparro (2012, 2013, 2015) studies the usability of different e-book mobile devices and applications and several usability issues have been reported. Jardina & Chaparro (2012) studied the usability of three touch-screen e-readers (iPad, Nook Tablet, and Kindle Fire) for essential book navigation tasks. Participants (N=16) rated all devices on their observation of workload and satisfaction. Objective data were collected while doing the tasks by the participants such as the time needed to complete the tasks, how many taps required to complete the tasks, and task success (participants giving two minutes for each task). The participants have to rate the complexity of the task directly after complete each task. Subjective data were collected by filling two questionnaires related to satisfaction and workload measurement (NASA-TLX). Finally, participants were interviewed in order to grade each reader based on a set of features and general preference. Outcomes revealed there are no considerable differences relating to the devices on identified satisfaction and workload. The menu structure of Nook was preferred more than the others. The iPad was preferred more than the Nook and Kindle

on highlighting search, and notes. The finally finding reported that in general participants were not satisfied with these devices (Jardina & Chaparro, 2013).

It is clear from this study that users are not satisfactory with the usability of these e-readers. The main purpose of this study is to measure the usability by examines the navigation tasks. However, the tasks given to the participants are limited and not cover all the important navigation tasks of e-book. For example, locate the table of content and navigation bar are very important to easy navigate the book content (Wilson et al., 2002b).

This study considers navigation tasks as important to increase the usability of the e-book. It is also reported by other studies like (da Silva & Dias, 2010; Mune & Agee, 2015; Pearson et al., 2010; Yi et al., 2011) that provide powerful navigation tools have the potential to increase the usability of the e-book.

From this, we can argue that the characteristic Navigation is affecting user satisfaction on the usability of e-book application. This characteristic was used to construct the fifth hypothesis in this study (Hypothesis H5).

As there are many universities and schools are starting toward offer e-textbooks in place of conventional paper textbooks, Jardina & Chaparro (2013) studied the usability, engagements, and satisfaction of two text-books applications. Although this option is, in general, more cost-effective, limited research has been done to show whether e-textbooks are a practical option in the classroom. They investigated the satisfaction,

engagement, comprehension, and perceived workload of two separate e-textbook applications. These applications are Kindle and Inkling.

The experiment is to test the ability of using these applications for studying by examining how easy to make notes, bookmarks, and highlighting. Besides, to check the ability to navigate, change text size, delete annotations, and search for a text. Both applications were tested using iPad, and each participant uses only one application for the usability test. Objective data were collected while doing the tasks by the participants, for example, the time taking to do each task, and task success (participants giving one minute for each task). After each task, participants have to rate the complexity of the task. Subjective data were collected by asking the participant to fill in two questionnaires related to satisfaction and engagement, as well as workload measurement (NASA-TLX). Participants (N=40) were also required to give a verbal feedback about their experience. Overall findings of the study show that participants were satisfied with e-textbooks for a study purpose, and there is no significant difference between the two applications in term of satisfactions, perceived workload, and comprehension. Nevertheless, Inkling was found to be to some extent better than Kindle for studying. Participants were found Inkling easier to completed most tasks.

While the previous study examines only two application, Jardina & Chaparro (2015) investigated the usability of eight e-textbooks reading applications. They intended to compare and contrast the features offered on them, with the focus on how these features implemented and evaluate the usability based on error investigation point of view. The eight e-textbooks are Chegg, ibook, VitalSource, Kno, Inkling, Nook, and Kindle. Their

study reported that current e-textbooks application have a variety of user interface, that mean there is no standardization in term of interface design. As a result, the student may waste his time in learning new interfaces every time he uses a new application, in addition to an interruption to study the course material. This study examined four main feature of the e-book. These features are bookmarking, take note, search by word, and locate notebook. Recommendations have been reported to each feature to improve the usability of these applications as in Table 2.

Table 2.5

Recommendation To Improve The Usability For E-Book (Jardina & Chaparro,2015)

Features	Recommendations
Bookmarking	Direct and easy access in all pages
	Standard bookmark icon
	Apparent visual indicator on the page to set a bookmark
Search For A Word	Using a smart search algorithm that giving tips as the user typing for completed phrases
	Standard search icon such as a magnifying glass icon
	Add some filters to the search results to help users refining the results
Make Note	Direct and easy access to make a note on all pages
	Standard and intuitive make a note icon
	A note box with default cursor or indicator focuses on permitting the user to type directly
	A clear save and cancel option when creating a new note
	Visual view to show where notes are placed on the page
Finding The Note	Simple access to the notebook from all pages by using a standard icon
	Separately view bookmarks, highlights, and notes
	Elasticity in the arrangement of notes by chapter or chronological

Limitations of the study are in the ambiguity of the number of expert reviewers; it seems like only one expert evaluate the eight applications. Also, this study can get more insights into design issues and errors if they applied a usability test with actual users and evaluated more features.

Another study to evaluate the academic e-books from user perspective done by Mune & Agee (2015a). They examined sixteen e-book platforms using academically. They investigated the usability features provided by these platforms, as well the accessibility from a student perspective, and practically for those with a disability. This study examined the usability of e-book cross-desktop, MacBook, and finally, they checked for mobile/tablet application using iPad2. Different browsers were using for viewing the e-book, and application and mobile website for mobile/tablet. The main usability features reported are the table of content, the ability to change font size or zooming, supporting moving to specific page number, the ability to take note, the ability to print, and the ability to download titles for offline used. Accessibility for these platforms in term of providing text-to-speech feature is essential for supporting reading with visual disabilities. Lack of providing text-to-speech had been reporting by almost platforms. Users need to download another application to access the materials while some platforms do not support at all. This study is significant; it examined many important features as well studied the accessibility. However, the evaluation depended only on checking if the e-book supports specific feature or not. The evaluation did not test how easy participants locate functions and their overall satisfaction.

2.8.1 E-Book Usability Evaluation Characteristics

The following are the characteristics proposed for evaluating the usability of the e-book application.

1. Readability: as defined by Seffah et al. (2006), readability is "the ease with which visual content can be understood". Readability is significant as the first-rate sign of comprehension which is the main element in the reading environment of the user experience (Yi et al., 2011). Readability may be enhanced with interface designs, for example, there are some design factors in a typographical format that increase the readability such as the font size, typeface, and line spacing (Wilson et al., 2002b; Yi et al., 2011). Conventional strategies stranded on the paper book should be included in electronic reading; E-book features must support of reading strategies employed by readers. For example, integration of encyclopaedias or dictionaries to facilitate students in understanding knowledge of particular domains mainly in educational reading and implementation of bookmarks or annotations to carry students' self-monitoring procedure (ChanLin, 2013).
2. Effectiveness: ISO 9241-11 defines Effectiveness as "Accuracy and completeness with which users achieve specified goals" (Bevan, 2000). Effectiveness is the ability in which the users can accomplish tasks by using the system, and the quality that can come from the outputs after accomplishing those tasks (Harrison et al., 2013; Seffah et al., 2001). Effectiveness may be complete to include the degree to which a system achieves its planned goal, or merely lay its utility (Coursaris & Kim, 2011).
3. Accessibility: the ability to use the system by users with some sort of disability like visual, psychomotor, and hearing disability (Seffah et al., 2001). The introduction of

accessibility features added in e-textbooks like hyperlinks and accessibility features such as text to speech provides the potential to raise the level of affective and psychomotor learning (Rockinson- Szapkiw et al., 2013).

4. Efficiency: according to ISO 9241-11 Efficiency is about how much resources spent in relation to the completeness and accurateness with which users reach targets (Bevan, 2000; Harrison et al., 2013). According to Coursaris & Kim (2011) Efficiency is "the degree to which the product is enabling the tasks to be performed in a quick, effective, and economical manner, or is hindering performance".
5. Navigation: people need to know what is within their environment (physical world, electronic world, or Virtual). Unfortunately, navigation is often not really a simple process. Electronic worlds provide both special opportunities and problems in navigation. As electronic worlds become vast, distributed, and even more integrated with day to day activities, increased support for navigation is necessary. Fortunately, good information and program design might provide such support and provide new means of navigating (Jul & Furnas, 1997). Studies like (da Silva & Dias, 2010; Mune & Agee, 2015; Pearson et al., 2010; Yi et al., 2011) show that provide powerful navigation tools have the potential to increase the usability of the e-book.

Table 2.6 summaries these characteristics according to the references.

Table 2.6

Usability Characteristics of E-Book Applications

Year	Authors	Title	Characteristics
2015	Mune, C., & Agee, A	Ebook Showdown: Evaluating Academic Ebook Platforms from a User Perspective"	Readability Accessibility Navigation
2015	Jardina, J. R., & Chaparro, B. S.	Investigating the Usability of E-Textbooks Using the Technique for Human Error Assessment"	Readability Efficiency Navigation
2013	Jardina, J. R., & Chaparro, B. S.	Usability of e-Readers for Book Navigation Tasks	Navigation
2012	Richardson Jr, J. V, & Mahmood, K.	"eBook readers: user satisfaction and usability issues"	Readability Effectiveness
2010	Siegenthaler, E., Wurtz, P., & Groner, R.	Improving the usability of e-book readers"	Efficiency Accessibility
2010	Pearson, J., Buchanan, G., & Thimbleby, H.	HCI design principles for ereaders	Readability Effectiveness Navigation

2.8.2 A Comparison with Some Usability Models

From the previous review of usability models for a software system and mobile applications, the current study compares the proposed model with three models. ISO 9241-11 and Nielsen as the widest usability models used. In addition, the PACMAD model which is a mobile application usability model. It is clear to the researcher from reviewing the related studies regarding e-book that there is no standard usability model

to evaluate the e-book. Table 2.7 depicts the comparison between the proposed model in this study and other models. We can see that the four models share efficiency. While Effectiveness appears in three models, Nielson does not include it. However, Readability, Accessibility, and Navigation are unique for this study model.

Table 2.7

Comparison with ISO 9241-11, Nielsen, and PACMAD Models

The Model In This Study	ISO 9241-11	Nielsen	PACMAD
		Learnability	Learnability
Readability			
Effectiveness	Effectiveness		Effectiveness
Accessibility			
Efficiency	Efficiency	Efficiency	Efficiency
Navigation			
		Error	Error
		Memorability	Memorability

2.8.3 Metrics Used In Previous Studies to Evaluate Mobile E-Book Usability

Previous studies evaluated e-book by measuring the existing of some features and how effective these features are implemented as well as the ease of usage. Table 2.8 presents the previous work for evaluating the usability of the e-book from 2010. Table 2.8 shows that every experiment evaluates the e-book by depending on the objectives of the study. Some studies focused on the navigation tasks. Other studies examined readability features and accessibility. In addition, some studies evaluated by using a standard model like the ISO examining the efficiency, effectiveness, and the satisfaction.

Table 2.8

Previous Publications for Evaluating the Usability of E-Book from 2010-2015

Year	Publication title	Authors	Type of e-book	Metrics used to evaluate	Method
2010	"HCI design principles for ereaders"	Pearson, J., Buchanan, G., & Thimbleby, H.	Three e-readers: Sony PRS 600, Kindle 2, and Sony PRS 300	- Support annotations - Support bookmark - Support page turning - Support hand drawing note - Support magnification - The ability to make more than one bookmark in one page - Buttons and menu are well labeled - Bookmarks can easily see on a separate page	Heuristic evaluation
2010	"Improving the usability of e-book readers"	Siegenthaler, E., Wurtz, P., & Groner, R.	Five e-readers: IRex Iliad, Sony PRS-505, BeBook, Ectaco jetBook®, Bookeen Cybook Gen	- The ability to open a book - The ability to increase font size - The ability to read the text in horizontal format. - The ability to open an audio book - task success - satisfaction with interface Design satisfaction with	Eye tracking with other usability methods such as usability test, questionnaires, and interviews

				Navigation satisfaction with Orientation satisfaction with Functionality	
2012	"eBook readers: user satisfaction and usability issues"	Richardson Jr, J. V, & Mahmood, K.	Five e-readers: Amazon Kindle; Barnes & Noble's Nook BNRV100; the Apple iPad MB292LL/A; Sony Digital Reader PRs-950; and Borders' kobo reader N647-BUS-S	- Easy to setup - Easy to download books - Easy to navigation - The ability to take notes - The ability to share titles - The ability to bookmark last reading - The ability to listen to audio book - Support dictionary	Survey
2012	"Usability of e-Readers for Book Navigation Tasks"	Jardina, J. R., & Chaparro, B. S.	Three readers with touch screen: Nook tablet, Kindle Fire, and iPad.	- Time taken to complete each task - The number of taps to complete a task. - Task success - Task difficulty	Usability test, questionnaires, and interview
2013	"Usability, Engagement, and Satisfaction of Two	Jardina, J. R., & Chaparro, B. S.	Two e-textbook applications: Inkling & Kindle	- Time taken to complete each task - The number of taps to complete	Usability test, questionnaires, and interview

	e-Textbook Applications"			a task. - Task success - Task difficulty	
2015	"Investigating the Usability of E-Textbooks Using the Technique for Human Error Assessment"	Jardina, J. R., & Chaparro, B. S.	Eight e-textbook applications: Chegg, ibook, VitalSource, Kno, Inkling, Nook, and Kindle	- Easy to bookmark - Easy to make note - Easy to locate a note - Easy to search a word - direct access to (bookmarks, notes, search) in all pages - use standard icons - providing smart search - a separate view of bookmarks, highlights, and notes - a visual view of the notes in the pages	Technique for Human Error Assessment
2015	"Ebook Showdown: Evaluating Academic Ebook Platforms from a User Perspective"	Mune, C., & Agee, A.	Sixteen e-book platforms in different devices include mobile devices	- Exact view - Page reflow - Zoom - The ability to change text (size, color, font style, letter/line spacing) - The ability to change background color	evaluation template to chick the availability of specific features

				- Providing table of content - Navigation - Search by text - Provide hyperlinks - Provide page forward and backward - Specify page number - the ability to highlight, bookmark, take notes, and audio notes - providing text-to-speech - Provide dictionary; pronunciation - Support printing/exporting	

2.9 Chapter Summary

This chapter presents in detailed the literature review. It gives a deep interview of the main concepts related to the title of this study includes the standard usability models. In addition, the chapter discussed the e-book revolution and the impact of this novelty in the current reading routine. The advantages and the disadvantages of e-book had discussed. In addition, the usability issues that have reported by previous studies were highlighted such as interface complexity, navigation problems, readability issues, lack of effective search tools. It also reviewing the preceding evalaution models relates to mobile e-book applications in order to identify the current charactaristics to evaluate e-book application and formulate related hypothese . The chapter also compares the present model with standard usability models.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter introduces the methodological procedure used in this study. The research framework and the outcomes from each phase are provided. The research design is considered as a diagram that manages the method on which the research is carried. The selection of research design depends on the nature of the research goals and questions under study by the researcher. According to the research questions in this study, a quantitative approach emploied to gather the data.

3.2 Research Procedure

The procedure of the research describes the methods that the study used to achieve the objectives. This study was involved four different phases. The first phase is to identify the requirements to evaluate the e-book application, which include the usability characteristics and metrics. The second phase is to develop a new e-book usability evaluation model. The third phase is to formulate the hypotheses. Finally, the evaluation phase, which used to validate the proposed model. Table 3.1 below presents the study procedure in detailed.

Table 3.1

Study Procedure

Phase	Activity	Approach	Outcomes
Identifying Usability Characteristics of Mobile E-book	Reviewing the literature identify the characteristics and metrics that have been used to evaluate e-books applications	Literature review	Usability characteristics and metrics for mobile e-book application
Developing E-book Usability Model	Developing a new e-book usability model to evaluate mobile e-book applications. Designing the questionnaire	Comparing and compiling the characteristics and metrics used in the previous studied	Usability model to evaluate mobile e-book applications
Formulating the Hypotheses	Constructing the related hypotheses to the proposed characteristics	Generating assumptions that assumed that the proposed characteristics have a significant effect on the user satisfaction and supported them by arguments from the previous studies	Five hypotheses
Evaluating the Proposed Model	Validating the model, evaluating three e-book application by using the proposed model	Usability test and Satisfaction Questionnaire	Validated model

3.2.1 Phase One (Identifying the Usability Characteristics and Metrics)

This phase was established to answer the first research question. In this phase, the study attempted to discover the characteristics that are typically used to evaluate mobile e-

book applications. Besides, identify the metrics related to the characteristics. A comprehensive analysis of e-book evaluation literature was made to understand the usability requirements. These requirements include the characteristics and metrics which are the base for developing the evaluation model. The outcome from this phase provides characteristics and metrics for the new model to evaluate the usability of the e-book mobile applications. By referring to the previous chapter work; Readability, Effectiveness, Accessibility, Efficiency, and Navigation are the characteristics that proposed to evaluate the user satisfaction of e-book application. In addition, the related metrics are compiled from Table 2.8. Some of the metrics are redundant in the studies and written in a different way, for example, pagination and specify the page number. Also, the study tries to simplify the model by merging similar metrics and come with one metric. For example, task difficulty, easy to (bookmark, take note, search, and locate note), and the number of taps required to complete a task. These metrics were compiled into one metric, which is: can perform task easily with a minimum number of taps. In addition, the metric: menu and button are well labelled and use standard icons, into main menu and icons are standard and clearly represent their function. Also, the metric: direct access to annotations in all pages and direct access to TOC, into clear, direct, and permanent navigation tools and annotations in all pages. Furthermore, some metrics were ignored such as exact view because this metric need to compare the e-book with the paper book.

3.2.2 Phase Two (Developing the Proposed Model)

In the second phase, the study was developed the model to evaluate the usability of mobile e-book application. The overall aim is to come with a comprehensive model

which can measure the user satisfaction of the usability of mobile e-book application. From the previous phase, the study combined almost all metrics used to evaluate and the study come with five characteristics and 37 metrics as shown in Table 3.2. Figure 3.1 depicts the proposed model.

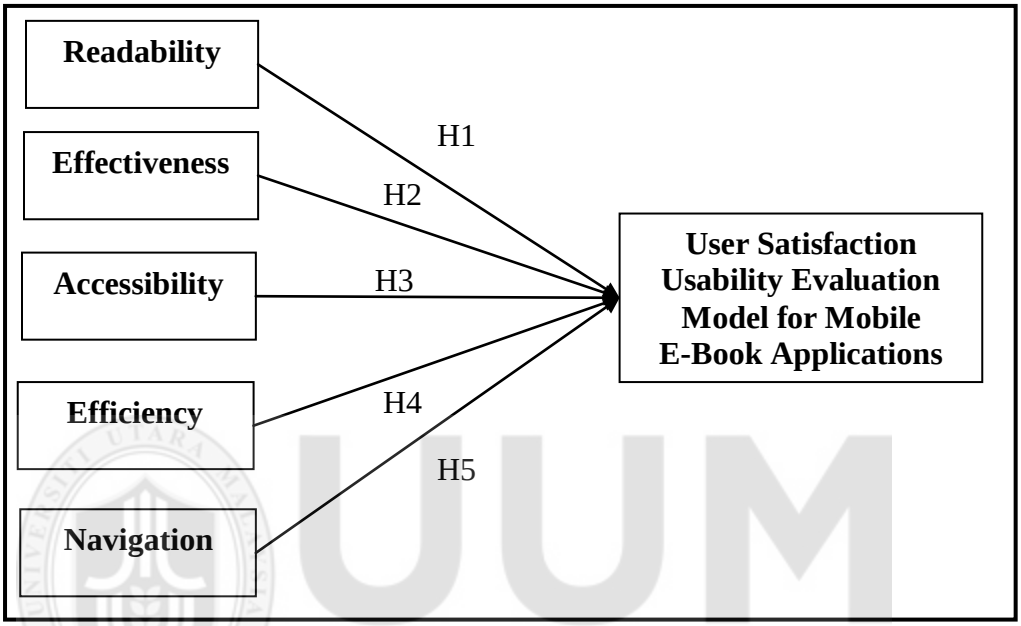

Figure 3.1. Usability Evaluation Model for Mobile E-Book Application

3.2.2.1 Questionnaire Design

After developing the model, the study was developed the instrument that used to measure the user satisfaction of mobile e-book application. The appropriate instrument for this purpose is the questionnaire. The Questionnaire is one of the effective method used to gather the data (Saunders, Lewis, & Thornhill, 2009). McNabb (2015) stated, "Questionnaires can be custom designed to meet the objectives of almost any type of research project". The questionnaire is to collect subjective data about the overall satisfaction of mobile e-book applications. Therefore, the type of the question is close-

ended. The questionnaire can by self-administered questionnaires or interviewer-administrated questionnaire (Saunders et al., 2009). This study implemented the interviewer-administrated questionnaire because the participant used the application first by performing some tasks (usability test). This is important to make sure that the participants test the application before giving their answers of the questions in order to improve the reliability of our data.

The instrument comprised two sections. The first section is about demographics information of participant and consists of five questions. The second section contains the satisfaction questions of the tested applications and has 37 questions as shown in Table 3.2. The participants evaluated the application usability by giving their satisfaction rating scale of five Likert scale (Vagias, 2006) and as similar studies (Jardina & Chaparro, 2012, 2013) have been used five Likert scale. Moreover, the five-point Likert scale is one of the most excellent ways to figure out the satisfaction of respondents (Olakunke, 2003). Refer to Appendix B for the Instrument.

Table 3.2

Characteristics and Related Metrics

Metric No.	Characteristics	Metrics	Source
M1	Readability	Provide features to change text format(size, style, color)	(Mune & Agee, 2015; Siegenthaler et al., 2010; Wilson et al., 2002b)
M2		Can change line space	(Mune & Agee, 2015)
M3		Provide a dictionary or encyclopedias	(Mune & Agee, 2015; Richardson Jr & Mahmood, 2012)
M4		Provide make note	(Jardina & Chaparro, 2015; Mune & Agee, 2015; Pearson et al., 2010; Richardson Jr & Mahmood, 2012; Wilson et al., 2002b)
M5		Provide bookmarking	
M6		Provide handwriting note	(Pearson et al., 2010)
M7		Provide highlighting	(Mune & Agee, 2015; Wilson et al., 2002b)
M8		Support magnification	(Mune & Agee, 2015; Pearson et al., 2010)
M9	Effectiveness	Sharing bookmarking and annotations with other applications and social networks	(Wilson et al., 2002b)
M10		Provide Intelligent search tool	(Jardina & Chaparro, 2015; Wilson et al., 2002b)
M11		Separate view of the list of bookmarking, highlighting, and notes	(Jardina & Chaparro, 2015; Pearson et al., 2010)
M12		The ability to delete bookmarking	(Pearson et al., 2010)

		and annotations	
M13		The ability to copy text	(Richardson Jr & Mahmood, 2012)
M14		Can Print page, section	(Mune & Agee, 2015)
M15		Offline reading	
M16		Can change Background color	
M17		Clear, direct, and permanent navigation tools and annotations in all pages	(Jardina & Chaparro, 2015; Wilson et al., 2002b)
M18		Easy setup	(Richardson Jr & Mahmood, 2012)
M19		Easy to download books	
M20		Support share books	
M21		Support more than one bookmark per page	(Pearson et al., 2010)
M22		Main menu and icons are standard and clearly represent their function	(Jardina & Chaparro, 2015; Pearson et al., 2010)
M23		Notes are visually viewed in pages	(Jardina & Chaparro, 2015)
M24		Support audio notes	(Mune & Agee, 2015)
M25		Page reflow to suit the device screen	
M26	Accessibility	Platform support text to speech/read mode	(Mune & Agee, 2015)
M27		Support audio books	(Richardson Jr & Mahmood, 2012; Siegenthaler et al., 2010)
M28		Viewed content in a suitable font size with the ability to change font size	(Mune & Agee, 2015; Siegenthaler et al., 2010)
M29		Can read text in horizontal format	(Siegenthaler et al., 2010)
M30	Efficiency	Can Complete tasks in a given time	(Jardina & Chaparro, 2012, 2013)
M31		Can complete a task easily with minimum number of taps	

M32	Navigation	Provide hypertext table of content	(Mune & Agee, 2015; Wilson et al., 2002b)
M33		Provide pagination (page number)	
M34		Provide navigation bar	Wilson et al., (2002b)
M35		Provide search tool	(Mune & Agee, 2015; Wilson et al., 2002b)
M36		Provide jump to page	(Wilson et al., 2002b)
M37		Provide page turn	(Mune & Agee, 2015; Pearson et al., 2010)

3.2.2.2 Instrument Validity

The concept of validity can be explained as the extent to which a set of measures is free from any systematic or non-random errors (Hair, Black, Babin, & Anderson, 2010). The validity of the instrument can be classified into two main categories namely: content validity and construct validity.

The content validity is the extent to which the instrument or measurement provides adequate coverage of the topic under study (Saunders et al., 2009). In this study, there is no need to check the validity of the content because the content of the questions is collected from the previous studies. In other words, the questions represent the metrics that have been used by other studies and as mentioned by Saunders et al. (2009) that one of the methods of achieving content validity is through precise definition of the research through the literature reviewed.

Construct validity is a type of validity that confirms that the concepts or scales are in fact measuring (Hair et al., 2010; Sekaran & Bougie, 2011). Factor analysis is the most commonly used test to determine the construct validity of the data (Sekaran & Bougie, 2011). However, for this study the sample size is not enough to do factor analysis as mentioned by Gorsuch (1997), the sample should be at least 100 for the purpose of factor analysis. The main goal from validating the questionnaire in this study is to check if the questions are meaningful and participants will not find them ambiguous.

According to Foddy (1994) and cited by Saunders et al. (2009) the discussion of the validity and reliability is the discussion about the sense-making of questions and answers. Foddy (1994) emphasises that "the question must be understood by the respondent in the way intended by the researcher and the answer given by the respondent must be understood by the researcher in the way intended by the respondent". According to Brace (2008), this validating can be achieved by do an informal pilot which requires the minimum that any questionnaire should undertake. Therefore, this study performed an informal pilot; the writer of the questionnaire should interview and carry out the questionnaire with a number of colleagues, usually no more than three colleagues.

3.2.3 Phase Three (Hypotheses Formulation)

The hypothesis is some supposition to be disproved or demonstrated, but also for a researcher, the hypothesis is a formal question that he intends to solve (Kothari, 2004).

This study presented the effect of the characteristics Readability, Effectiveness, Accessibility, Efficiency and Navigation on the user satisfaction of the usability of the mobile e-book applications. Therefore, this study assumed that these characteristics have a significant effect (positive relationship) on the user satisfaction. These hypotheses state what we are looking for and it is a proposition which can be put to the test to determine its validity. These hypotheses tested after collecting the data. The hypotheses are summarised in Table 3.3.

Table 3.3

E-book Evaluation Characteristics and Hypotheses

Hypotheses	Source	Argument
H1: Readability has a significant effect on user satisfaction of the usability of e-book application	(Jardina & Chaparro, 2015; Mune & Agee, 2015; Pearson et al., 2010; Richardson Jr & Mahmood, 2012)	Readability increase user satisfaction (Gibson & Gibb, 2011; Mekonnen, 2014; Wilson et al., 2002b; Yi et al., 2011)
H2: Effectiveness has a significant effect on user satisfaction of the usability of e-book application	(Pearson et al., 2010; Richardson Jr & Mahmood, 2012)	Evaluating the usability of e-book requires analysing its effectiveness (Lewandowski et al., 2003)
H3: Accessibility has a significant effect on user satisfaction of the usability of e-book application	(Mune & Agee, 2015; Siegenthaler et al., 2010)	Providing features to increase the accessibility of the e-book such as text-to-speech will increase the usability (Agee, Mune, & Gonzalez, 2015; Biancarosa & Griffiths, 2012; Mune & Agee, 2015)
H4: Efficiency has a significant effect on user satisfaction of the usability of e-book application	(Jardina & Chaparro, 2015; Siegenthaler et al., 2010)	Evaluating the usability of e-book requires analysing its Efficiency (Lewandowski et al., 2003; Siegenthaler et al., 2010)

H5: Navigation has a significant effect on user satisfaction of the usability of e-book application	(Jardina & Chaparro, 2015; Mune & Agee, 2015; Pearson et al., 2010)	Provide powerful navigation tools will increase the usability of the e-book (da Silva & Dias, 2010; Mune & Agee, 2015; Pearson et al., 2010; Yi et al., 2011)

3.2.4 Phase Four (Evaluating the Model)

A usability test or a usability study was conducted to validate the model. It is a general method to evaluate and discover problems of applications. Typically, users employ the application, after that they can provide feedback by completing a satisfaction questionnaire, or participate in interviews (Hussain et al., 2014).

The proposed model was used to evaluate three e-book applications in mobile device. These applications are identified by conducting a pilot study to determine the three popular e-book applications use by UUM students to read the electronic books. The pilot study also asked about the platforms (the operating system i.e. Android or iOS) as well as the type of mobile devices used for this purpose.

The results of the pilot study showed that almost all students read the e-books by used Adobe Acrobat Reader application (86.73%), Android platform (78.35%), and their smart phones (86.73%). The top three applications employed in the Android platform are Adobe Acrobat Reader, Ebook reader, and Amazon Kindle respectively. Appendix A shows the pilot study result.

By referring to the results of pilot study, the evaluation was emploied the Smart phones devices, Android platform, and the top three applications (Adobe Acrobat Reader, Ebook reader, and Amazon Kindle respectively). In this study, the validation had done

by asking the participants to evaluate the three applications by using one Smartphone with 5.5-inch screen size.

3.2.4.1 Population and Study Sample

Population refers to the entire group of people, events, or things of interest that the researcher wants to investigate (Sekaran & Bougie, 2011). It is a gathering of elements that the study is interested in examining. For this study, the target population is the actual users of the e-book application.

A sample could be defined as part of the target population of interest to be studied and can be statistically referred to as a sub-collection that is selected from a population of interest. A sample is thus a subgroup or subset of the population (Sekaran & Bougie, 2011). For this study, the sampling frame for e-book user is academic users (students) from Univirsti Utara Malaysia (UUM). The reasons behind that are to generate awareness among students about the availability of useful applications for reading electronic books in the market of their hand phone apps store. Additionally, to compare the satisfaction of different educational level.

The usability guides and previous studies concluded that 80% of the usability issues can be detected by using four to five participants and ten participants can detect approximately 90% (Duh et al., 2006). Besides, there are many assumptions about the adequate sample size for regression analysis. Green (1991), attributable to Tabachnick & Fidell, who recommended that even though 20 SPV (subjects per variable) would be

preferable, the minimum mandatory SPV should be five. Recently, Austin & Steyerberg (2015) reported that the minimum number of observations to conduct an unbiased evaluation of coefficients is two per variable (2 SPV) for multiple regression models. As a result, five variables need minimum ten observations, but a larger ratio will give a higher statistical power. Therefore, for the usability test, ten participants were recruited to test every application; total for the three applications are 30 participants. This number of participants is also adequate and addressed the minimum requirement for the regression analysis (six SPV).

3.2.4.2 Usability Testing

The focus of this study is to examine the effect of the proposed models (the characteristics) on the user satisfaction. To achieve the objectives of this research, the study was designed task scenarios and a questionnaire to collect the data from the respondents to provide answers to the research questions. This study also collected data about the time taken for all tasks, and data about tasks requests help from the researcher, Figure 3.2 illustrates the procedure of conducting the usability test. The study was randomly choosed the participants (students from UUM). The test took place in different locations in UUM environment. The researcher explained to the participants about the objectives of the experiment. Prior the test the researcher asked the participant to install the application and open an e-book. The researcher guided the participants in how to use these applications by developing a task scenario, and the participants worked individually to generate a general condition that was close to reality, see Appendix B for the task scenario. The participants can ask the researcher if they need some help, this

helps to identify the difficult tasks. A sufficient time to complete the tasks was given (around 30 minutes). After finishing the test, participants filled out a satisfaction questionnaire, see Appendix B. The overall time taken to complete all the tasks was recorded by using a stopwatch application.

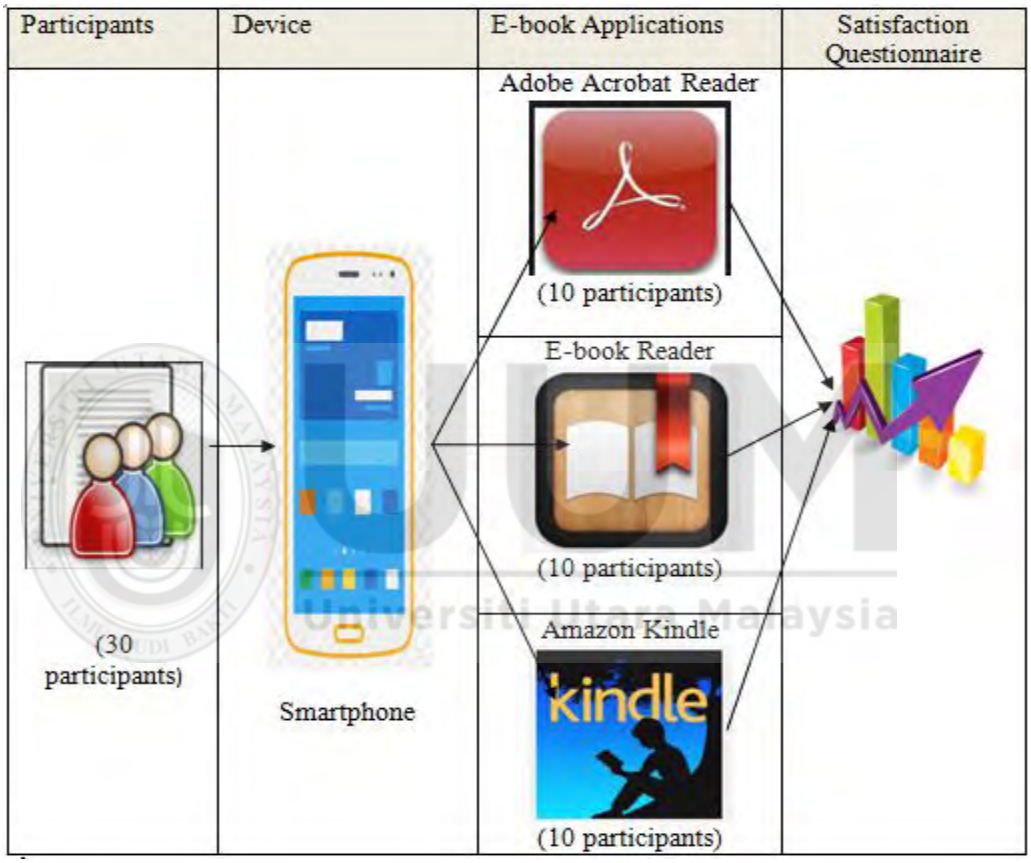

Figure 3.2. E-book Usability Testing Procedures

3.3 Data Analyzing and the Analysis Tools

After collecting the data, it has to be processed and analysed according to the outline laid down for the purpose of the study. This step is crucial for scientific research, and to guarantee that we have all appropriate data to create comparisons along with analysing.

The word analysis points to the calculation of certain measures on the side of looking for patterns of relationship that exist between data groups (Kothari, 2004).

In this study, the data collected is quantitative data coming from the questionnaires and the usability test. For the quantitative data, this study used Statistical Package for Social Science (SPSS) version 23.0 as an analysing tool. Quantitative data analysing tools help the researchers to describe, present, explore and examine the relationships within the quantitative data (Saunders, Lewis, & Thornhill, 2011). Analysing the data and testing the hypotheses requires several statistical techniques. In this study, these stages are: (1) descriptive statistics (2) correlation analysis (3) multiple regression analysis.

3.3.1 Descriptive Statistics:

It allows the study to report and correlate variables numerically (Kothari, 2004). Both the readers and the researcher use it to review the data into graphs and tables for better understanding and analysing the results. It was used to examine the data based on the important categories in the sample including the gender, age, mobile experience, and e-book experience. Furthermore, this study was examined user satisfaction with the proposed model and compares the satisfaction between the different applications used in the test. In this study, the descriptive statistics were undertaken using central tendency and variation statistics, including means, minimum, maximum, and standard deviation.

3.3.2 Correlation Analysis (Hypotheses Testing)

Correlation analysis is described as the assessment of the relationship between two variables (Hair et al., 2010). This study aims to examine the relationships between

different variables comprising of Readability, Effectiveness, Accessibility, Efficiency, and Navigation as the independent variables, and Satisfaction as the dependent variable. The correlation test will help to determine the direction of the relationship between these variables and the strength of these relationships, for the purpose of testing the hypotheses.

3.3.3 Multiple Regression Analysis

Multiple regression is used to analyze the impact of more than one independent variable on one single dependent variable (Pallant, 2013). In this study, multiple regressions are employed to measure the e-book usability model fit by predict the strongest item effecting the user satisfaction among Readability, Effectiveness, Accessibility, Efficiency, and Navigation as the independent variables.

3.4 Chapter Summary

This chapter explains the research procedure that involved four phases, which are identifying, developing, hypotheses constructing, and evaluation to achieve the research objectives. In the identifying phase, the researcher determined the e-book usability characteristics and metrics. These characteristics and metrics used to develop a specific evaluation model for mobile e-book. The study constructing five hypotheses to verify the proposed model. In the last phase, the evaluation phase used to validate the proposed model by using both usability test and satisfaction questionnaire. the data collected in this study is quantitative data which used to compare the satisfaction between the tested applications. In addition, the collected used to test the hpotheses by using the correlation test as well as multiple regression analyse to muasure the model fit.

CHAPTER FOUR
MODEL EVALUATION

4.1 Introduction

This chapter concentrates in the evaluation of the proposed model. The results from the collected data employed to test the hypotheses and validate the model. Multiple regression analysis used to check the effect of the proposed characteristics on the user satisfaction for the usability of mobile e-book applications.

4.2 Validity and Reliability

4.2.1 Validity

This study performs an informal pilot study to examine the validity of the questionnaires. The main goal is to check the understandability of the questions from the respond point of view. The researcher invited three PHD students in three different meeting and discussed with them the construct of the questions. The researcher updates the questionnaire after each meeting. On the first meeting, the participant got some confusing in some questions for example: I can share my titles with others, and after the discussion, he suggested change from title to book. In addition, the questions regarding the Efficiency have been updated to suit the setting of the test. The second participant suggested adds the mobile experience to the first section. Besides, he favours adds some explanations to some terms such as magnification, text format, and pagination. The third participant is the most comfortable one; he did not have any comments in the questions in term of the meaning. However, he observed some format and grammar mistakes.

4.2.2 Reliability

Reliability is concerning about the consistency of the study findings which dependent on the reliability of the data collection techniques or analysis procedures used in the study (Saunders et al., 2011). Cronbach's Coefficient Alpha is the most common value used to estimate the reliability (Dunn, Seaker, & Waller, 1994). In this study, Cronbach's Coefficient Alpha is equal to 0.860 which indicates a good consistency among the items of the scales whereby Cronbach Alpha's values higher than 0.70 indicated acceptable consistency among the items of a scale (Dunn et al., 1994). Table 4.1 shows the reliability test of the instrument and Table 4.2 shows the reliability test for each independent variable.

Table 4.1

Scale Reliability Statistics

Cronbach's Alpha	N of Items
.860	37

Table 4.2

Cronbach's Alpha for Each Independent characteristic

Characteristics	No. Of items	Cronbach's Alpha
Readability	8	.637
Effectiveness	17	.758
Accessibility	4	.551
Efficiency	2	.716
Navigation	6	.771

From the previous table, it is clear that Accessibility has a poor Alpha. After checking the Cronbach's Alpha if item deleted for each characteristic, the researcher observes that deleting some items improved Alpha for some scales to an acceptable Alpha whereby

the acceptable scale is between 6 and 8 (Loewenthal, 2001). Table 4.3 illustrate the items that removed from each scale.

Table 4.3

Items Removed From the Scales

Scale	Items Number (Questions)
Readability	6
Effectiveness	8
Accessibility	3 and 4
Navigation	5

After deleting those items, the total items remaining are 32 items and Cronbach's Alpha for the scale is 0.847 as in Table 4.4. Moreover, all the questions have Alpha less than 0.847 or equal (Refer Appendix C). The new Alpha for the independent variables is above six; Table 4.5 depicts the results.

Table 4.4

Reliability Statistics after Deleting Five Items

Cronbach's Alpha	N of Items
.847	32

Table 4.5

New Alpha for the Independent Variables

Characteristics (scale)	No. Of items	Old Cronbach's Alpha	New Cronbach's Alpha
Readability	7	.637	.668
Effectiveness	16	.758	.770
Accessibility	2	.551	.834
Efficiency	2	.716	.716
Navigation	5	.771	.815

4.3 Data Screening

Data analysing should ensure the ability for providing a true picture of the Actual phenomena. Screening the data considers aspects such as the non-response bias, response rate, and outliers. Ignoring such issues can affect the validity of the data and, accordingly, the results of the study. In this study, the non-response bias and respond rate are not considered because the questionnaire is an interviewer-administrated questionnaire.

4.3.1 Multivariate Outliers

In the data collection phase or/and data entry phase, a researcher possibly will make errors and consequently generate particularly unreliable values. These values are considered to be outliers (Hair et al., 2010). Thus, data with a very high or low value compared with the other values of data is an outlier. The study validity may be affected by the existence of outliers; for that reason, a researcher has to discover the outliers and solve these issues (Hair et al., 2010; Pallant, 2013). Mahalanobis distance is one of the common techniques used to discover the outlier's cases. Mahalanobis distance shows the distance between the case and the centroid of all cases for forward planner variables. Hair et al.,(2010) mentioned that a considerable distance pointed out that the case is an outlier. The outlier's cases are determined by plotting Mahalanobis distance's value against Chi-square percentile points.

The SPSS 23.00 was used to investigate the values of Mahalanobis distance (M-D), which resulted in values placed between 0.913 and 10.639 (See Appendix D). The M-D can be compared to a chi-square distribution with degree of freedom (DF) equal to the number of predictors in the Regression. The p-value, i.e. the right tail area, for the M-D is computed as a new variable with SIG.CHISQ () function. The p-values that are less than 0.001 are considered as outliers (Tabachnick & Fidell, 2007). By doing so, the results indicate that the minimum value for p is 0.05903 which is bigger than 0.001. Therefore, there are no outlier's questionnaires in this study (See Table 4.6).

Table 4.6

Descriptive Statistics for P Values of M_D

	N	Minimum	Maximum	Mean	Std. Deviation
Pmah	30	**.05903**	.96930	.5099502	.28373586
Valid N (listwise)	30				

4.4 Regression Analysis

Multiple regression analysis is used when the researcher assumes that several independent variables contributing to the variation of the dependent variable, Hair (2010) added that using multiple regressions could increase the accuracy of the predictions for the dependent variable over one independent variable. One advantage of multiple regression analysis is that the researcher can explore the interdependency between variables (Lattin, Carroll, & Green, 2003). Three types of multiple regressions that can be used by the researchers, namely: standard or simultaneous, hierarchical or sequential, and stepwise. The standard or simultaneous multiple regression for all the independent variables is where all the variables are entered at the same time in the

equation, based on that all independent variables are assumed to be of equal importance (Pallant, 2013). Therefore, this type of analysis is the appropriate method to be used in the present study.

Before conducting multiple regression analysis, the next sections discussed the several assumptions that have to be met and they are Multicollinearity, Normality, Linearity and Homoscedasticity (Bluman, 2012; Pallant, 2013).

4.4.1 Multicollinearity

Multicollinearity is an assumption that should be checked to conduct the regression analysis. According to Hair et al. (2010), Multicollinearity is the measurement to which the other variables can explain a variable in the analysis. According to Tabachnick & Fidell (2007), Multicollinearity problem appears when the correlations are more than 0.90 and exists between independent variables. This assumption can be tested using Tolerance Value and Variance Inflation Factor (VIF) tests. Hair et al. (2010) defined tolerance as "the amount of variability of the selected independent variable not explained by the other independent variables", whereas VIF is the opposite of Tolerance Value.

In this study, the Tolerance Value and VIF were used to investigate Multicollinearity. The result shows that each independent variables had Tolerance Value greater than 0.1, and VIF value less than 10, indicating that there is no Multicollinearity between the independent variables. The values of Tolerance Value and VIF for each independent variable are shown in Table 4.7 (Refer Appendix E).

Table 4.7

Testing of Multicollinearity

Model		Collinearity Statistics	
		Tolerance	VIF
	Readability	.708	1.412
	Effectiveness	.632	1.582
	Accessibility	.803	1.246
	Efficiency	.630	1.586
	Navigation	.733	1.364

a. Dependent Variable: Satisfaction

4.4.2 Normality

Normality refers to the normal distribution of the residuals about the predicted dependent variable (Pallant, 2013).Two types normality test was employed to chick the normality by using SPSS, explicitly: a normal curve in a histogram, and skewness and kurtosis. First, the histogram tests were conducted for the independent variables (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) and dependent variable (Satisfaction). Figure 4.1 shows the histograms and normal curves of the test. It is clearly that the normal curve is regular and bell shaped. Consequently, the normality statement is met.

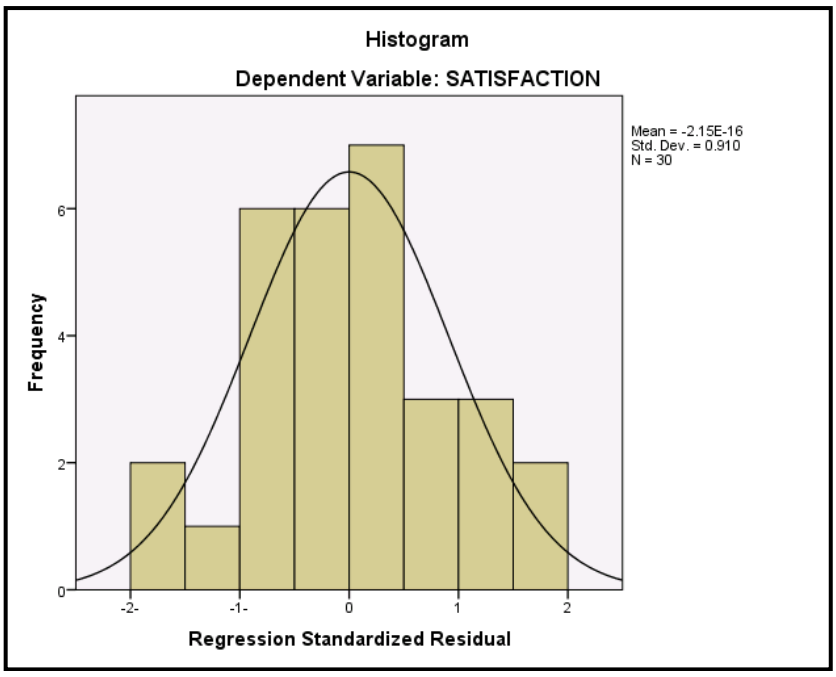

Figure 4.1. Normality Test for Satisfaction

Furthermore, according to Byrne (2013), the normality of the data can be determined from the skewness and kurtosis. Normal data is data with skewness between -2 to +2, and kurtosis between -7 to +7 (Byrne, 2013).The results in Appendix F showed that the entire ratios of the items are in the accepted range of skewness and kurtosis.

4.4.3 Linearity

Linearity means there is a straight-line relationship between residuals and the dependent variable (Pallant, 2013).The linearity statement is set, which several authors have suggested, on normal probability plot of the regression standardised residual. The result of conducting the linearity test for each of the independent variables and the satisfaction as a dependent variable appeared in Figure 4.2. The figure shows that approximately all the points' line in a rationally in a straight line diagonal line. Therefore, the assumptions of linearity are met.

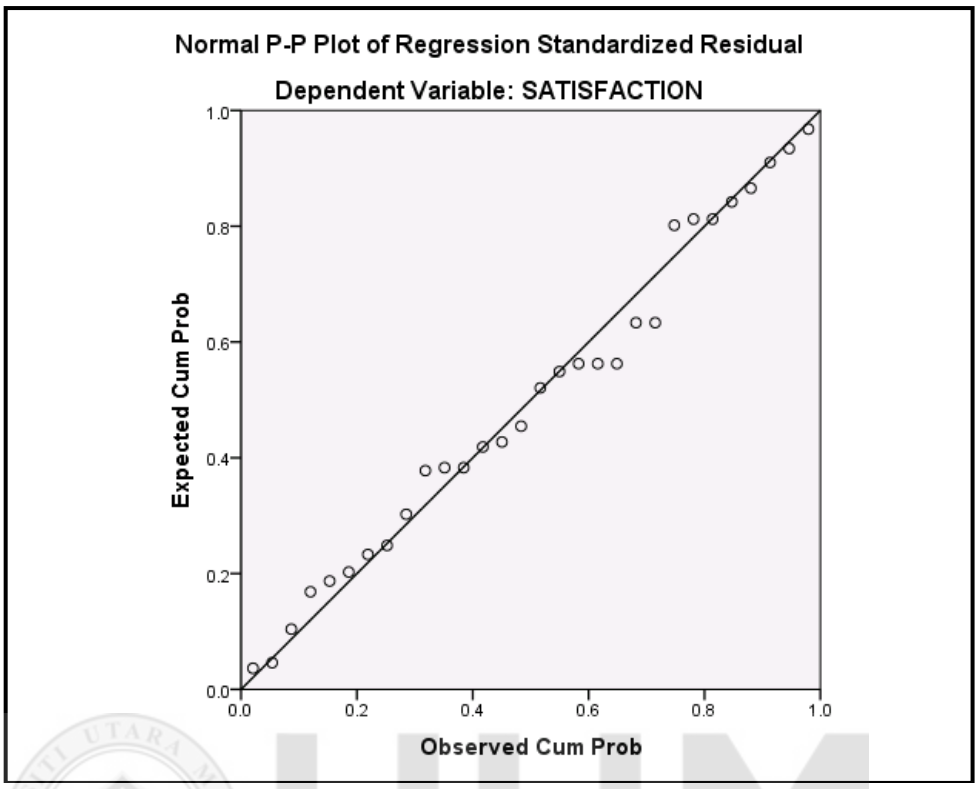

Figure 4.2. Test of Linearity for Satisfaction

4.4.4 Homoscedasticity

According to Pallant (2013), "assuming that the variance of the residuals about dependent variable scores should be the same for all predicted scores" is called Homoscedasticity.

Homoscedasticity test is conducted by using scatter plot (Hair et al., 2010; Pallant, 2013). Scatter plot diagrams of standardised residuals are used to verify the homoscedasticity for the user satisfaction. Figure 4.3 indicates the outcome of this test. The figure shows that there is no systematic pattern such as curvilinear or the existence of the residuals on one side. Therefore, the assumption of homoscedasticity was met.

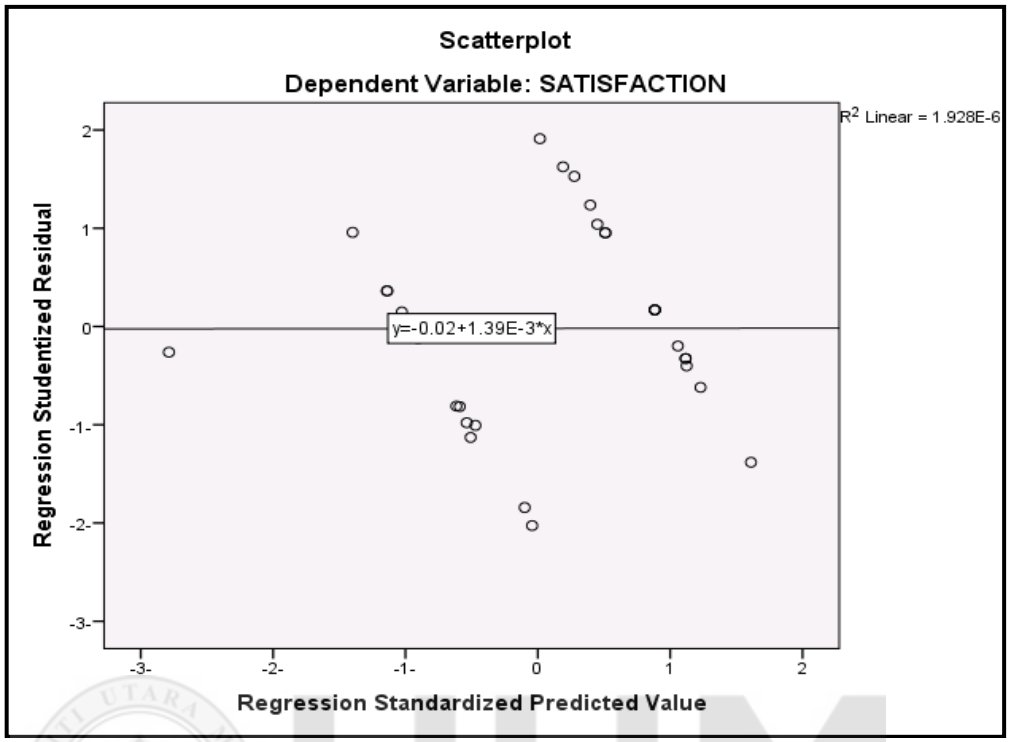

Figure 4.3. Test of Homoscedasticity for Satisfaction

4.5 Correlation Analysis

Correlation analysis is defined as a statistical method used to explain the relationship direction and strength of any two variables (Pallant, 2013). Correlation coefficients are usually used to determine either the positive or negative and either weakness or strength of the linear relationship between the two variables. One of the most commonly used methods for identifying the correlation coefficients between the two variables is the Pearson Product Moment Correlation Coefficient (r). It has a range of values between +1 and -1. On the one hand, if the two variables have r is close to +1, this means that there is a strong positive relationship between the variables. On the contrary, a strong negative correlation between the two variables exists when r value is close to -1. Moreover, If the value of r is equal to zero, no relationship (association) between the variables exists

(Pallant, 2013). According to Hair et al. (2010), several assumptions must be met if the researcher wants to use r in investigating the correlations between the variables of the study as follows: First, the variables should be interval or ratio data. Second, the relationship under examination should be linear. Finally, the last assumption states that variables under examination should come from a normally distributed population. All these assumptions are met in this data set because all independent and dependent variables are measured by the interval scale, and both linearity and normality assumptions have been achieved as was discussed previously. Thus, using the Pearson Product Moment Correlation Coefficient is appropriate in this study to determine and interpret the strengths of the correlations between two variables and to test the hypotheses (See Table 4.8). Table 4.9 shows the results of the correlation analysis for all variables involved in this study (Refer Appendix G).

Table 4.8

Cohen's Guideline of Correlation Strength

rValues	Strength of Relationship
r = +.l0 to .29 or r = -.l0 to -.29	Small
r = +.30 to .49 or r = -.30 to -.49	Medium
r = +.50 to l.0 or r = -.50 to -.l.0	Large

Table 4.9

Correlation Test between All Variables

Variables	Readability	Effectiveness	Accessibility	Efficiency	Navigation	Satisfaction
Readability	1					
Effectiveness	.362*	1				
Accessibility	.348	.143	1			
Efficiency	.276	.546**	-.049	1		
Navigation	.315	.354	-.111	.420*	1	
Satisfaction	**.595****	**.637****	**.521****	**.523****	**.544****	1
Sig. (2-tailed)	**.001**	**.000**	**.003**	**.003**	**.002**	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed)

4.5.1 Discussion of the Correlation Results (Hypotheses Testing)

This section discusses the results of Correlation analysis by highlighting the Satisfaction issues in mobile e-book application, based on the findings obtained from the five hypotheses testing. The five hypotheses assumed a significant effect (positive relationship) of the five characteristics (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) on the Satisfaction. So, the accepted value of r is bigger than zero and less or equal to one. In addition, the significant level is 0.05. Discussion of results is divided according to the type of hypotheses.

A Pearson's correlation was run to determine the relationship between the five characteristics and the Satisfaction. The results shows that the Satisfaction has a positive significant correlations with the five characteristics whereby the largest correlation is with Effectiveness (r=0.637, p-value=.000), these relationships are significant at the p

level of 0.01 and 0.05. The correlation analysis tests the five hypotheses that proposed a positive relationship between the five characteristics and the user satisfaction of the mobile e-book usability. The results show that all the Hypotheses are supported as the value of p is less than the significant level (Sig. Level is 0.05). Table 4.10 summarise the result of the hypotheses testing

H1. The Relationship between Readability and Satisfaction

The relationship between the Readability and Satisfaction is based on the literature. The study found that Readability has a significant positive effect on the Satisfaction (r=0.595, p-value=0.001), so this hypothesis is accepted. This result is consistent with many studies in literature which illustrate this relationship (Colombo & Landoni, 2011; Elliott, 2003; Gibson & Gibb, 2011; Mekonnen, 2014; Patel & Morreale, n.d.; Pearson et al., 2010; Wilson et al., 2002b; Yi et al., 2011).

H2. The Relationship between Effectiveness and Satisfaction

The relationship between the Effectiveness and Satisfaction is based on the literature. This study found enough evidence to support a significant positive relationship between Effectiveness and Satisfaction (r=0.637, p-value=0.000). This result supports the hypothesis of the study. This result is consistent with many studies in literature which illustrate this relationship (Pearson et al., 2010; Richardson Jr & Mahmood, 2012).

H3. The Relationship between Accessibility and Satisfaction

The relationship between the Accessibility and Satisfaction is based on the literature. The study found that Accessibility has a positive significant effect on the Satisfaction (r=0. 521, p-value=0.003). This result supports the hypothesis of the study. This result is

consistent with many studies in literature like which illustrate this relationship (Agee, Mune, & Gonzalez, 2015; Biancarosa & Griffiths, 2012; Mune & Agee, 2015; Siegenthaler, Wurtz, & Groner, 2010).

H4. The Relationship between Efficiency and Satisfaction

The relationship between the Efficiency and Satisfaction is based on the literature. The result shows that Efficiency has a positive significant relationship with the satisfaction (r=0. 523, p-value=0.003). This result supports the hypothesis of the study. This result is consistent with many studies in literature which illustrate this relationship (Jardina & Chaparro, 2015; Siegenthaler et al., 2010).

H5. The Relationship between Navigation and Satisfaction

The relationship between the Navigation and Satisfaction is based on the literature. The study found that Navigation has a positive effect on the Satisfaction (r=0.544, p-value=0.002). This result supports the hypothesis of the study. This result is consistent with many studies in literature like (da Silva & Dias, 2010; Jardina & Chaparro, 2013; Mune & Agee, 2015; Pearson et al., 2010; Wilson et al., 2002b; Yi et al., 2011).

Table 4.10

Summary of Results for Hypotheses Testing Results

No.	Hypothesise	r	P Value	Decision
H1	Readability--------> Satisfaction	0.595	.001	Supported
H2	Effectiveness--------> Satisfaction	0.637	.000	Supported
H3	Accessibility--------> Satisfaction	0. 521	.003	Supported
H4	Efficiency --------> Satisfaction	0. 523	.003	Supported
H5	Navigation--------> Satisfaction	0.544	.002	Supported

4.6 Multiple Regression Analysis

Correlation analysis is usually used to determine the relationship between two variables regarding of the strength and direction of the relationship, while multiple regression analysis is used to determine the relationship between more than one independent variable and one or more dependent variable. In the process of multiple regressions, the researcher can in one equation predict a single dependent variable by entering several independent variables (Hair et al., 2010; Pallant, 2013).

In the present study, a standard multiple regression is used to investigate the relationship between the independent variables (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) and the dependent variable (Satisfaction). To this end, Hair et al. (2010) established steps to evaluate the multiples as described as follows:

1. Checking the F value to determine the statistical significance of the model.
2. The R^2 should be verified to determine if its value fits
3. Examining the regression coefficients and their Beta coefficient (b) to determine the independent variables that have statistically significant coefficients

Table 4.11, 4.12 illustrate the results from running the multiple regressions between the dependent variable and all the independent variables (Refer Appendix H).

Table 4.11

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.906[a]	.821	.784	.26619	.821	22.015	5	24	.000

a. Predictors: (Constant), NAVIGATION, ACCESSIBILITT, EFFECTIVENESS, READABILITY, EFFICIENCY

b. Dependent Variable: SATISFACTION

Table 4.11 shows that F value is statistically significant (F=22.015, P<0.05), which indicates that the model is statistically significant as suggested by (Hair et al., 2010). The R^2 for this model is also fit (R^2=0.821, adjusted $R^{2=}$0.784), which means that the independent variables explain 78.4% of the variation of the dependent variable. This result is consistent with Hair et al. (2010) recommendation as shown in Table 4.12.

Table 4.12

Acceptable R^2 Values

Significance Level = 0.01					Significance Level = 0.05			
	Number of independent variables				Number of independent variables			
Sample size	2	5	10	20	2	5	10	20
20	45	56	71	NA	39	**48**	64	NA
50	23	29	36	49	19	23	29	42
100	13	16	20	26	10	12	15	21
250	5	7	8	11	4	5	6	8
500	3	3	4	6	3	4	5	9
1000	1	2	2	3	1	1	2	2

Source: (Hair et al., 2010)

This table shows that when N=20 and the number of independent variables is 5 and P value=0.05, the suggested R^2 is 48%. The sample size of this study is 30 (more than 20), and the number of independent variables is 5; therefore, R^2=0.821 indicating that the value of this model is statistically significant and stable.

The results from the multiple regression shows which independent variable is significantly contributing to the satisfaction level. This results are presenting in Table 4.13.

Table 4.13

Regression Model between the independent variables and the dependent variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta(b)		
1	(Constant)	-.361-	.403		-.896-	.379
	Readability	.121	.077	.161	1.565	.131
	Effectiveness	.253	.101	.271	2.498	.020
	Accessibility	.225	.045	.477	4.950	.000
	Efficiency	.165	.090	.200	1.837	.079
	Navigation	.316	.087	.366	3.633	.001
**** P < 0.001, *** P < 0.01, ** P < 0.05, * P < 0.10.						

a. Dependent Variable: Satisfaction

As shown in Table 4.13, the independent variables (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) contribute significantly to explain the dependent variable (Satisfaction). The highest contribution is from Navigation variable where (B=0.316, t=3.633, Sig=0.001), explaining 31.6%, and has significant influence

(while holding other predictors in the model constant). Followed by Effectiveness (B=0.253, t=2.498, Sig=0.020), explaining 25.3%, and has significant influence. Followed by Accessibility (B=.225, t=4.950, Sig=.000) explaining 22.5%, and has significant influence. Efficiency and Readability have a low contribution in explaining the dependent variable whereby Efficiency (B=0.165, t=1.837, Sig=0.079), explaining 16.5%, and Readability (B=0.121, t=0.1.565, Sig=0.131), explain 12.1% and both of them do not have a significant influence on the satisfaction.

In general, multiple regression procedures will estimate a linear equation of the form: $Y = A + b_1*X_1 + b_2*X_2 + ... + b_p*X_p$, where Y is the response or the dependent variable, A is the Y-intercept The Y-intercept is the value of the Y variable when all Xs = 0, and the predictors X1… Xp, the regression coefficients b1… b_p. The regression coefficients (or *B* coefficients) represent the *independent* contributions of each independent variable to the prediction of the dependent variable. According to the results shows in Table 4.12, the contribution of the independent variables (X1=Readability, X2=Effectiveness, X3=Accessibility, X4=Efficiency, X5=Navigation) to explain the dependent variable is as the following:

$$Y= -0.361+0.121X1+0.253X2+0.225X3+0.165X4+0.316X5=0.719$$

As a result, the proposed model explained 71.9% from the user satisfaction level of the usability of e-book application, which indicates a good fit of the proposed model.

4.7 Chapter Summary

This chapter provides the model evaluation and the data analysis of the study. It incorporates the Reliability, Outliers, Multicollinearity, Normality, Linearity, and Homoscedasticity tests to measure the goodness of the collected data. Moreover, the chapter included the methods of correlation to test the hypotheses and regression analysis to measure the model fit. The results show that all the hypotheses are supported and the proposed model is significant and fit. The proposed characteristics explained 71.9% from the user satisfaction of mobile e-book application.

CHAPTER FIVE
USABILITY REPORT

5.1 Introduction

A usability test was conducted to validate the model, it is a method to evaluate and discover problems of the applications. It is designed to look for the extent in which the interface makes it possible for a user's ability to complete routine tasks. Typically, users employ the application, after that they can provide feedback by filling out a satisfaction questionnaire, or participate in interviews (Hussain et al., 2014). The proposed model has been used to evaluate three e-book applications in mobile device. These applications are Adobe Acrobat Reader, Ebook Reader, and Amazon Kindle.

The device utilized for the test is a Smartphone mobile with touch screen and 5.5-inch screen size. The device is portable as it is lightweight mobile (140 grammes). The operating system used in this mobile phone is Android KitKat 4.4.2. The most important feature that is available in KitKat which is essential to reading E-book is the ability to print (Print wherever, whenever), you can print documents, photos, and web pages from your mobile devices. In addition, the user can print to several printers connected to HP ePrint printers, Google Cloud Print, and to any printers have apps in the Google Play Store. Figure 5.1 depicts the device used in the test.

Figure 5.1. The Smartphone Used In the Test.

5.2 Overview to the Usability Testing

The usability test was taken place in the UUM library and School of Computing (SOC), and the duration of the test is two weeks, from 11- 26/July/2016. Thirty participants participated in the test, ten participants for every application. The length of the sessions was varying from participant to participant. Maximum duration is thirty minutes. The selection of the participants is random and dependence on the availability and acceptance of the participants. Firstly, we give the participant a brief explanation about the purpose of the test. Secondly, the participants test the application according to the tasks scenario. The session captured each participant's time taken to complete all the tasks by using a stopwatch and taking notes about the tasks that the participants request the evaluator help. Finally, the participants fill out the questionnaire. The first section of the questionnaires is about demographic data. Figure 5.2 depicts some participants while doing the test.

Figure 5.2. Some of the Participants

The data collected from the first section shows that two-thirds of the participants have more than three years experience in using mobile applications. In addition, half of the participants have more than three years experiences in mobile E-book applications and only four participants have never used any mobile E-book application. Table 5.1, 5.2 summarise their experience in mobile applications and E-book application respectively.

Table 5.1

Descriptive Statistics for Participants Mobile and E-Book Application Experience

	Mobile applications experience	Ebook applications experience
Mean	3.57	3.17
Std. Deviation	.728	1.053

Table 5.2

Distribution of Participants by Mobile Applications and Ebook Applications Experience

		Mobile applications experience		E-book applications experience	
		Frequency	Percent	Frequency	Percent
Valid	Never	1	3.3	4	13.3
	Less than one year	1	3.3	2	6.7
	1-3 years	8	26.7	9	30.0
	More than 3 years	20	66.7	15	50.0
	Total	30	100	30	100

5.2.1 Profiles of Participants

The study scheduled thirty participants over the two testing weeks. The first five participants conducted the test at School of Computing in 11/July/2016 and the rest at UUM Library from 12-26/July/2016. Table 5.3 summarises the descriptive statistics of participants' (gender, age, and educational level). Table 5.4 shows the distributions of participant gender.

Table 5.3

Descriptive Statistics about Gender, Age, and Educational Level

		Participant gender	Participant age	Participant educational level
N	Valid	30	30	30
	Missing	0	0	0
Mean		1.43	2.63	2.43
Std. Deviation		.504	.718	.679

Table 5.4

Distribution of Participants by Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	17	56.7	56.7	56.7
	Female	13	43.3	43.3	100.0
	Total	30	100.0	100.0	

It is apparent from Table 5.4 that the number of the male participants is bigger than the female, but the difference is not very high and less than five (male=17, female=13). The participant's age is ranged from 21 to 40 years, 40% from 21-30 years old and 46.67% from 31-40 (See Figure 5.3). There are two reasons of this age range; the first one is because almost participants are postgraduate students since the usability test was taken place during the study holiday and almost undergraduate students are out campus. The second reason is that postgraduate students both master and doctoral in UUM are in the range of 21 to 40 years. The majority of the participants are doctoral students (53.33%) follows by master students (36.67%), the rest are bachelor students (10%) as shown on Figure 5.3.

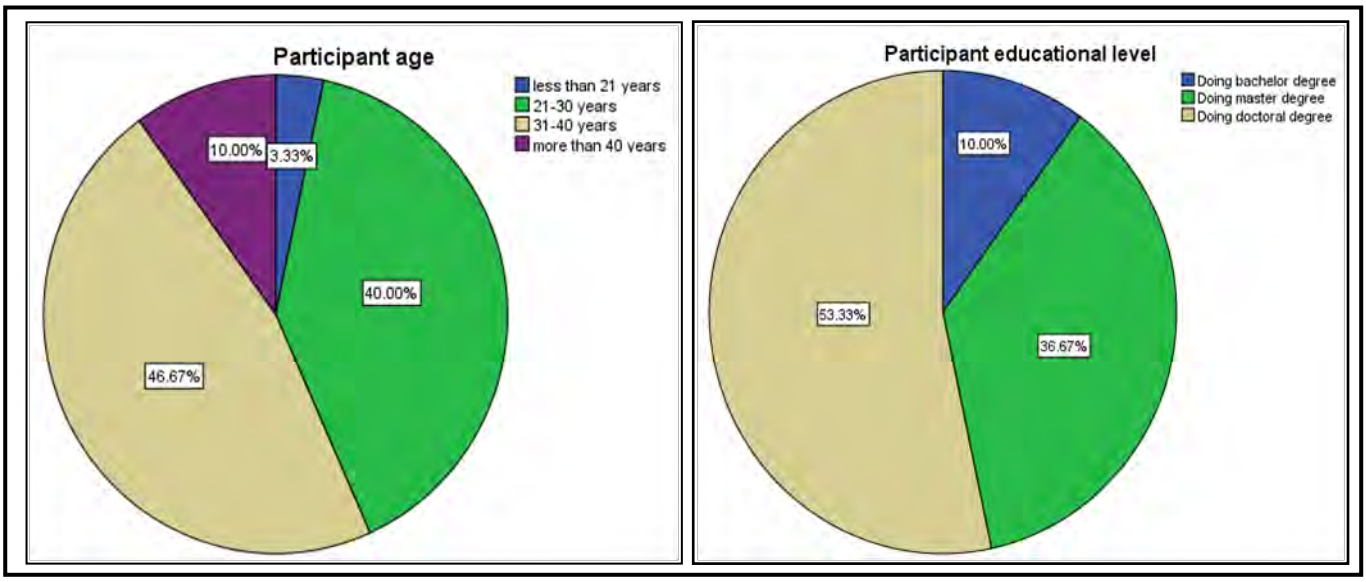

Figure 5.3. The Participant's Age and Educational Level

5.3 Results

This section shows the results of the usability test and questionnaire in term of time taken, difficult tasks, and user satisfaction.

5.3.1 Time Taken

In this study, the participants work individually with the tested materials. The reason of this is to generate a general condition that was close to reality (Siegenthaler et al., 2010). Therefore, this study cannot collect directly the time taken for each task, but the researcher recorded the overall time taken for all tasks. According to a similar study conducted by Jardina & Chaparro (2013), one minute is enough to complete each task. This study results also support the previous study result. The table 5.5 shows that the mean time taken per task is 0.76 minute and the maximum time is 1.30 minute. These results support that the time taken per task is around one minute.

Table 5.5

Statistics for 15 Tasks in Minute

N=30	Time Taken	TimePerTask
Mean (Minute)	11.4073	.7605
Std. Deviation	4.42461	.29497
Minimum (Minute)	3.00	.20
Maximum (Minute)	19.51	1.30

5.3.2 Difficult Tasks

One of the benefits of the usability test is to identify the difficult tasks. In this study, the researcher informs the participants that they can have some help on the difficult tasks, and as a result, the researcher can identify those tasks. The results from the test reports some difficulties in the navigation task such as located the table of content (Task1) and go directly to the specific page (task 14), this is consistence with similar studies. In addition, participants faced some problems with the readability tasks such as copy text, take note, and translate or define the word (tasks 5, 6, 7 respectively). Those functions are significant for academic reading (ChanLin, 2013). The participants also face some issues in task 8 (locate the annotations), but after they found them they proceed easily with task 9 (delete these annotations). It is also evident for those who found difficulties with changing font size (task 10) that they can deal easily with the following tasks regarding font style, line spacing, and night mode (task 11 and 12). Furthermore, the most difficult task is task 15 activate reading mode (read aloud).

5.3.3 Usability Satisfaction

This section is to present the usability satisfaction results for the three applications, compare the results, and discuss the findings. The second step after the participant test

the application is to fill out the questionnaire to determine the user satisfaction. The study reported about the satisfaction level among different patterns such as the gender, educational level, and e-book experiences. Moreover, the study reported about the overall satisfaction and specific satisfaction in term of the proposed characteristics. Table 5.6 summarises the general satisfaction level of the three applications as well as reported about the satisfaction level of the five usability characteristics of e-book applications.

5.3.3.1 Overall Satisfaction and Satisfaction among the E-Book Characteristics

This part illustrates the level of satisfaction between the three applications. Basically, the general satisfaction and the degree of satisfaction about the e-book usability characteristics. Table 5.6 summarises the general satisfaction level of the three applications as well as reported about the satisfaction degree of the five usability characteristics of e-book applications.

Table 5.6

Satisfaction Comparison between the Three Applications

Satisfaction Level	Adobe Acrobat		Ebook Reader		Amazon Kindle	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Overall Satisfaction	3.3480	.27998	3.3739	.47991	3.8716	.41055
Readability	3.3286	.37526	3.6857	.4607	4.5143	.46754
Effectiveness	3.6813	.39905	3.4438	.58515	3.8438	.51052
Accessibility	1.7000	.85635	1.9000	1.28668	2.5500	1.30064
Efficiency	3.9500	.64334	3.7000	.75277	4.0500	.55025
Navigation	4.0800	.59029	4.1400	.81131	4.4000	.49889

Table 5.6 shows that participants are most satisfied with the usability of Amazon Kindle (mean=3.8). The results also indicate that there is no difference in the user satisfaction between Adobe Acrobat Reader and Ebook Reader (mean=3.34 and 3.37 respectively). However, the minimum satisfaction among the three applications is 2.45 for Ebook Reader application (Refer Appendix I).

The findings from this study indicate that readability has a positive effect on the user satisfaction of the mobile e-book usability, which is consistence with the previous studies results. This study also compares the readability between the three applications. Table 5.6 shows that Amazon Kindle is the best one supports readability features (mean=4.5143). Followed by Ebook Reader (mean=3.6857) and then Adobe Acrobat Reader (mean=3.3286). The reason beyond this satisfaction with kindle readability is

because Kindle is the only one who supports changing the text style, line spacing, and have a built-in dictionary which are valuable tools for active reading. The minimum readability is reported by the Adobe Acrobat Reader (Min=2.71) whereby the PDF format is the only e-book format supported by this application which affected the readability of the application due to the constraints of the PDFformat.

This study also indicates that Effectiveness has a significant effect on the user satisfaction of the mobile e-book usability, which is consistence with the previous studies results. This study compares the Effectiveness between the three applications. Table 5.6 shows that Amazon Kindle is the best one in supporting Effectiveness features (mean=3.8438), followed by Adobe Acrobat Reader (mean=3.6813), then Ebook Reader (mean 3.4438). Previous studies reported that e-book applications have to support active reading, accessibility, and navigation tools effectively. They insisted that the implementation of such some tools like the annotations and the navigation must be simple, direct, and available on all pages.

The findings from this study also indicate that Accessibility has a significant effect on the user satisfaction of the mobile e-book usability, which is consistence with the previous studies results. This study compares the Accessibility between the three applications. The results in table 5.6 shows that Amazon Kindle is the best one in supporting Accessibility features (mean=2.55). Additionally, Adobe Acrobat Reader and Ebook Reader are approximately equally (mean=1.7 and 1.9 respectively). Previous studies reported that e-book applications have the potential to increase the accessibility by supporting features like text-to-speech and audio books which are relevant for readers

with some vision issues. The three applications are failing in doing so. In fact, Amazon Kindle supporting these features but not in Android platform.

The findings from this study indicate that Efficiency has a positive effect on the user satisfaction of the mobile e-book usability. This study also compares the Efficiency between the three applications. The outcomes in table 5.6 shows that Amazon Kindle is the best one in Efficiency (mean=4.0500), followed by Adobe Acrobat Reader (mean=3.9500), then Ebook Reader (mean=3.7000). The mean time to complete all tasks is 11.40 as shown in Table 5.5 whereby 15 tasks are accomplished by the participants required no more than one minute as reported by previous study and supported by this study.

The findings from this study also show that Navigation has a significant effect on the user satisfaction of the mobile e-book usability, which is consistence with the previous studies results. This study compares the Navigation between the three applications. Table 5.6 shows that there is no significant difference between Adobe Acrobat Reader and Ebook reader (mean=4.08 and 4.14 respectively). Amazon Kindle is a slightly better than the others (mean=4.4). Despite that all the applications supporting navigation in a proper manner by providing a hyperlink TOC, page number, search tool, and so on. The Amazon Kindle is unique in term of the robust of page flipping (page turning). The application can keep the last page of reading holding while the user was flipping the document. The user can go back to the previous page very easy as well as the visual view of the position of his last reading page to the left or the right; Figure 5.4 depicts the flipping mechanism. This navigating style helps students, for example, to navigate

between citations in the text to the list of references at the end and back again. In Thayer et al. (2011), the authors looked at the design of e-readers for academic, they explored the relationships between different academic reading strategy (scanning, search reading, skimming, receptive reading, and active reading) and different navigation types. The study reported that supporting anywhere navigation, flipping among several reference lists, a hypertext table of contents, and an easy path back to the start page could achieve a successful navigation for scholarly reading.

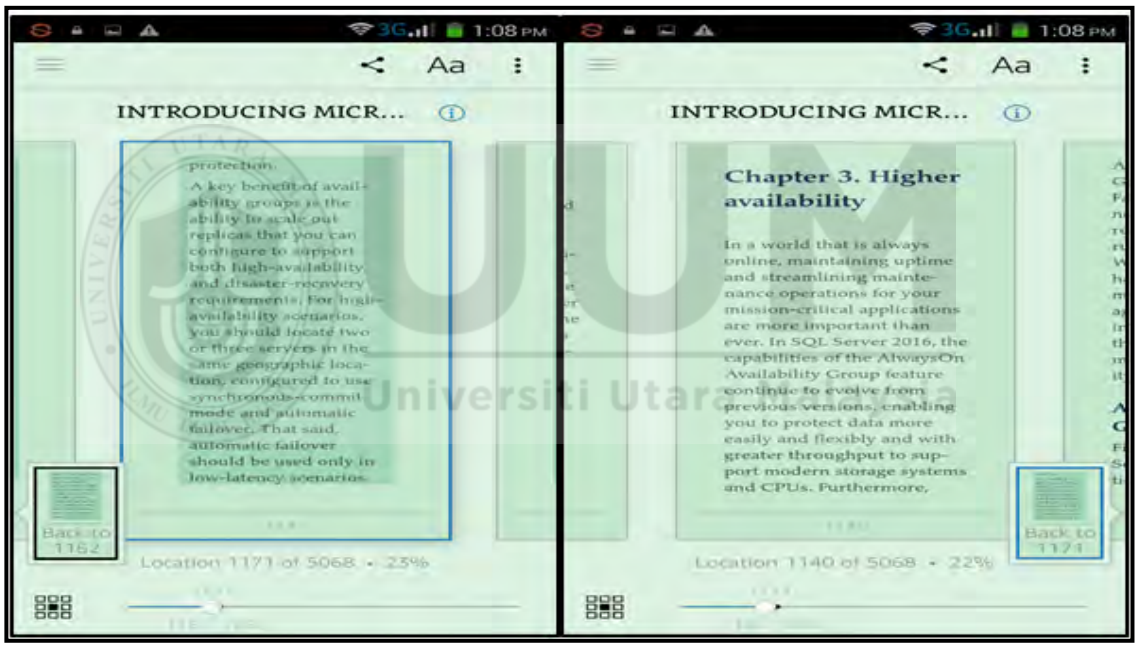

Figure 5.4. Kindle Flipping Mechanism

5.3.3.2 Satisfaction by Gender

It is also common to compare the satisfaction by looking at some patterns like the gender, educational level, and e-book experience. In Schomisch, Zens, & Mayr (2013)

the results showed that there are no large gender-related differences in the acceptance and the usability of e-readers and e-books. This study results also show that there is no significant difference in the satisfaction level between male and female, mean for male is 3.44 and for female is 3.63. Table 5.7 shows the comparison. However, the results show that a female participant reports the minimum satisfaction.

Table 5.7

Satisfaction Level among Gender

Participant gender			Statistic	Std. Error
Satisfaction	Male	Mean	3.4483	.08750
		Std. Deviation	.36079	
		Minimum	2.96	
		Maximum	4.24	
	Female	Mean	3.6395	.15370
		Std. Deviation	.55419	
		Minimum	2.45	
		Maximum	4.38	

5.3.3.3 Satisfaction by Educational Level and E-Book Experience

A previous study indicated that the relationship between students and e-book is increasing when the education level increase, this mean postgraduate students are more related to e-book than undergraduate students (Lamothe, 2013). This study found that there is no notable difference between different educational levels in term of satisfaction (Bachelor degree=3.52, Master degree=3.59, Doctoral Degree=3.48), see Table 5.8.

The results also show more satisfaction when e-book years of experience are increased (Never=3.21, Less than one year=3.42, from 1-3years=3.47, more than 3 years=3.66),

see Table 5.9. Accordingly, this study concludes that the satisfaction is increasing when the relationship (years of experience) with e-book applications is increasing.

Table 5.8

Satisfaction Score and Level among Educational Level

Participant educational level			Statistic	Std. Error
Bachelor degree	SATISFACTION	Mean	3.5293	.28332
		Std. Deviation	.49073	
Master degree	SATISFACTION	Mean	3.5921	.12156
		Std. Deviation	.40317	
Doctoral Degree	SATISFACTION	Mean	3.4896	.12685
		Std. Deviation	.50739	

Table 5.9

Satisfaction Level among E-Book Experience

Ebook applications experience			Statistic	Std. Error
Never	SATISFACTION	Mean	3.2117	.28108
		Std. Deviation	.56216	
Less than one year	SATISFACTION	Mean	3.4288	.54625
		Std. Deviation	.77251	
1-3 years	SATISFACTION	Mean	3.4785	.13319
		Std. Deviation	.39958	
More than 3 years	SATISFACTION	Mean	3.6616	.10924
		Std. Deviation	.42307	

5.4 Discussion and Recommendations

One of the important outcomes of the usability test is defining the problems faced by the participants. This study observes several difficulties in using these applications.

5.4.1 Discussing the Difficulties

The participants faced difficulties on printing the books. Ebook Reader and Amazon Kindle did not support printing at all. On the other hand, Adobe Reader support printing with some difficulties in the implementation of this process. The applications also did not promote sharing specific annotations, which facilitates discussing them wider. Furthermore, the applications fail in supporting read aloud feature which has been identified as an important feature to increase the accessibility of the e-book. However, Amazon Kindle is supporting this feature for other platforms such as iOS or Kindle devices.

The applications are quite different in the interface design as well as in the features that they support. Adobe reader supports only PDF files, thus the number of features that it can support are less than the other applications. Features such as changing the font size, style, and line spacing cannot support for this e-book format. Otherwise, the application is supporting magnification perfectly. Ebook Reader supports both PDF and other reflowable formats. This application is better than Amazon Kindle in term of providing more features to read PDF files whereby Kindle is only viewing the PDF files with the ability to zoom only. On the other hand, Ebook reader has some drawbacks. The application does not support some active reading features such as copy text, jumping to specific pages, and translating the words. However, e-book reader facilitates locating the

annotations by providing a separate view for each type of the annotations. The participants like the wide range of features the Amazone Kindle have. The main complaint in Amazon Kindle is the limitation with the PDF files as this application is just a viewer for this type of e-book.

5.4.2 The Recommendations

The recommendations part provides suggested changes and a justification for each recommendation includes a seriousness rating. The following recommendations, on Table 5.10, will improve the overall ease of use and address the areas where participants experienced problems or found the interface/information architecture unclear. This study as well emphasising in implementing previous study recommendation to increase the usability such as (Gibson & Gibb, 2011; Jardina & Chaparro, 2012, 2013, 2015).

Table 5.10

Recommendations

Applications	Changes	Justification	Severity
All the tested applications	Providing an intelligent search tool	The search functionalities are a considerable extra value of e-books against printed books. In addition, current users are familiar with online search engines like Google which supporting intelligent search algorithm. Users usually type a few letters and the suggested words and sentences are giving to him. This is making search faster and resulting in smaller number of typing mistakes since users do not type the complete inquiry.	Medium
Adobe Acrobat Reader	Providing a separate view (by using a standard icon that present a notebook) for the user annotations such as the notes and the highlights along with the bookmarks	Looking for a note that has been saved before is essential similar to making this note. Easy access to these annotations from any page is also important to provide more usability to the e-book.	High
Ebook Reader	Enabling copy the text	In the scholarly work, users usually need to copy text	High

Table 5.10

Recommendations

Applications	Changes	Justification	Severity
	Enabling jumping to specific pages	for several purposes, reading on non-linear which request frequently jumping between pages, and need to translate and define some difficult words.	
	Providing a built in dictionary		
Amazon Kindle	Add a standard icons for the bookmark and the note book on the top bar	The users are usually bookmarking and looking for their previous notes, so these tasks are frequently used and the user need them to be direct and visual on the page and not under any menu	High
	Enabling text to speech function for Android platform	Android is the leader platform in the market of mobile devices. As a result, the accessibility of the Kindle e-book will be increase when supporting this feature for Android.	Medium

5.5 Chapter Summary

This chapter presents the usability test results. The chapter discusses an overview to the usability test and the participant's profiles. The descriptive analysing was used to compare the satisfaction among different patterns such as the gender, educational level, and the e-book experience. It is also used to generate insights about how these applications support the proposed characteristics in this study. The results show that the Amazon Kindle is the most usable and satisfactory. It is clear that the current applications used in this evaluation are addressing some of the usability issues that reported by previous studies such as the issues regard the navigation and the supporting of active reading function for scholarly reading. However, these applications are quite different in the interface design. Finally, the difficulties and problems in these applications have discussed and the recommendations to improve the usability have been given in order to come with a usable e-book applications.

CHAPTER SIX
CONCLUSION

6.1 Introduction

Base on the primary objective of this study which is to design a usability evaluation model for mobile e-book application, this study has performed three phase to achieve this goal.

Firstly, the first step is to identify the requirements to develop the model which are the main characteristics and the associated metrics. Secondly, the developing phase to develop a usability evaluating model for mobile e-book application based on the user satisfaction. The questionnaire has been designed to measure the user satisfaction. Finally, the evaluation phase has been established to validate the proposed model by implementing a usability test followed by the satisfaction questionnaire. The data collected from this phase has been analysing by using the SPSS to validate the model.

6.2 Objectives Achievement of the Study

This study identified five characteristics to evaluate the usability of mobile e-book applications. These characteristics are (Readability, Effectiveness, Accessibility, Efficiency, and Navigation). The study also identified 37 e-book evaluation metrics. These characteristics and metrics used to develop the proposed model. To do so, the study designs the e-book usability evaluation model, which measures the user satisfaction regarding the usability of the e-book application. Therefore, the study designs the two instruments, which are Task scenarios and satisfaction questionnaire.

The result from this correlation analysis shows that the five characteristics proposed in this study have a significant relationship with the user satisfaction (the five hypotheses are supported). The results from multiple regressions providing information about the most contributed variable to the user satisfaction. The results show that all the five independent variables contributing to more user satisfaction with using the e-book applications. However, three of these characteristics are providing significantly namely: Navigation, Effectiveness, and Accessibility respectively. The sample data fail in proving the significant of both Readability and Efficiency but both of them have a positive relationship with the satisfaction. The highest contribution is from Navigation variable explaining 31.6%, and has significant influence (while holding other predictors in the model constant). Followed by Effectiveness explaining 25.3%, and has significant influence. Followed by Accessibility explaining 22.5%, and has significant influence. Efficiency and Readability have a low contribution in explaining the dependent variable whereby Efficiency explaining 16.5%, and Readability 12.1% and both of them do not have a significant influence on the satisfaction. The proposed model is significantly fit and measuring 71.9% from the user satisfaction of mobile e-book application

Furthermore, The results from the usability test show that the time needed for each task is around one minute, this result is consistence with a similar study conducted by Jardina & Chaparro (2013) who reported about that one minute is enough to complete each task.

The previous study indicated that the relationship between students and e-book is increasing when the education level increase (Lamothe, 2013). This study finds that there is no significant education-related difference in term of satisfaction. The results

also show that when the years of experience are increasing, the satisfaction also is increasing. Therefore, this study concludes that the satisfaction is increasing when the relationship with e-book is increasing.

This study involves both male and female participation, and the results show that there is no significant gender-related difference in the satisfaction level.

This experiment observes that the tested applications addressed some of the usability issues that have been reported by previous studies. However, the interface design is quite different. It is clear that all the applications support the navigation perfectly expect some weakness in Ebook reader which not support go to specific pages and with the very robust navigation system in Kindle for some e-book. All the applications also support search function but not as intelligent as online search engines. The Kindle reader has a drawback in the implementation of the set bookmark and the notebook. As these features are important, the user must direct access to them as well as using standard icons to represent them. However, Kindle listed them under one of the menus.

A study conducted by Mune & Agee (2015) reported about the lack of supporting text-to-speech feature by some platforms which have a high potential to support reading by users with some vision disabilities, this study also reporting the same issue.

6.3 Research Contribution

The contribution of this study to the knowledge of matters associated with the usability of mobile e-book applications is by providing insights into the main characteristics

which increase the user satisfaction. The contributions of the present study categorised into theoretical and methodological aspects.

6.3.1 Theoretical Contributions

This study contributes to the e-book literature by providing more evidence of the impact of the proposed characteristics (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) on e-book applications usability. Thus, determining the most important characteristics to increase the usability will guide the developers and the evaluators to the most important related features to include and evaluate. In addition, the study found that the proposed model is fit and measure 71.9% from the user satisfaction. Besides, this study contributes in discovering the usability issues in the tested applications and given recommendations to overcome these problems.

6.3.2 Methodological Contributions

The literature review found that a small number of studies have empirically examined the effect of the proposed characteristics (Readability, Effectiveness, Accessibility, Efficiency, and Navigation) on the user satisfaction especially by using a Smartphone. Therefore, this study combined the characteristics from several studies as well as adapted the evaluated metrics and designs to develop the instruments to measure these variables to suit the research settings in mobile devices.

The first instrument is by designing a task scenario to guide the participants during the usability test. This study takes into account the main principle to design a task scenario published by (Sauro, 2013). The scenario includes seven task scenario covering fifteen

tasks representing the goals from the test. The second instrument is the Satisfaction questionnaire. This questionnaire is designed to be specifically used to evaluate e-book applications. Content and constructs validity have checked the validity of this questionnaire, and the reliability test has checked the reliability.

6.4 Limitations of the Study

Even though the study has some contributions, it as well has some limitations that may have an effect on its validity or generalisability.

First, this study investigated the impact of some specific e-book characteristics on the satisfaction. The study focuses on the characteristics related to mobile e-book applications. This study not includes any hardware or content design/presentation metrics as well as any general mobile application interface design metrics.

Second, the scope of the study limited the number of tested applications and platforms due to the time constraint. Thus the study designs the experiment to suit these limitations which force the researcher to implement a usability test followed by a questionnaire to collect the data; the participants have to give their score about specific applications which maybe they never use before.

Third, the target participant is only academic student due to the time constraint and language constraint whereby the mother language in Malaysia is Malay.

Fourth, the Smartphone devices have many screen sizes; this study uses only one size due to the cost constraint. Additionally, before this study, the researcher conducted a similar study and designed the experiment to use the participant mobile phone, but all the participants excused because they do not have enough space on their devices. Therefore, the researcher also considers this constraint during the research design.

Fifth, the study is conducted in Malaysia, and as Malaysia is one of the developing countries, the study finding may be generalising only to related environments.

6.5 Future Work

The limitations of any study are always an inspiration for new works. Consequently, this section provides the recommendations for future research.

First, this study identified the impact of some specific e-book characteristics on the satisfaction. The study focus on the characteristics related to mobile e-book applications, in regards to this, it would be necessary to include general mobile application characteristics.

Second, this study test only three applications and one platform. Future studies should increase the number of applications and platforms as well as increase the sample size.

Third, this study uses only quantitative data. Future studies should use a mixed method (survey and interviews) to obtain more insights.

Fourth, the study use of a single class of individuals (academic students) to participate in the experiment the questionnaires may result in mono-response bias. Consequently, future studies should include different categories of respondents such as pre-college students, librarians and Academic lectures.

Fifth, to overcome the screen size constraint, future studies may not include any usability test and the participants evaluate whatever e-book application they use by using any mobile screen size.

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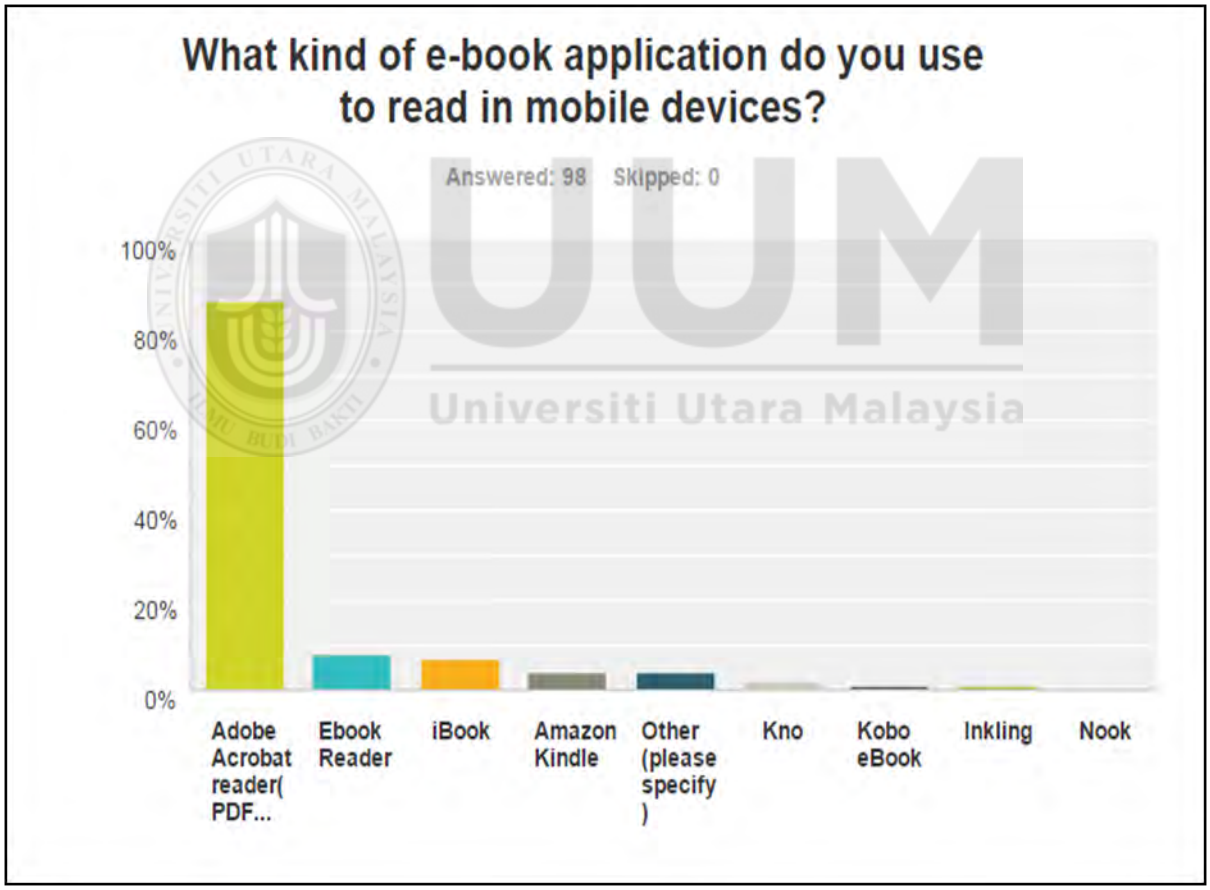
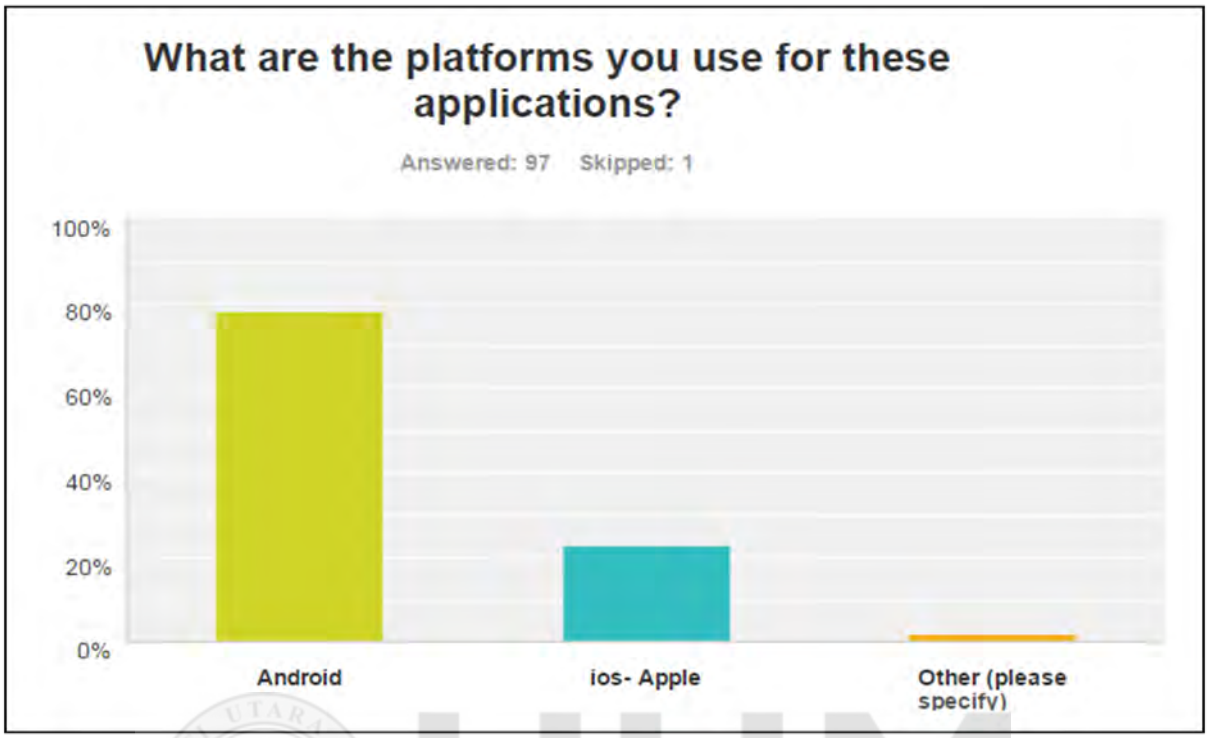
Appendix A

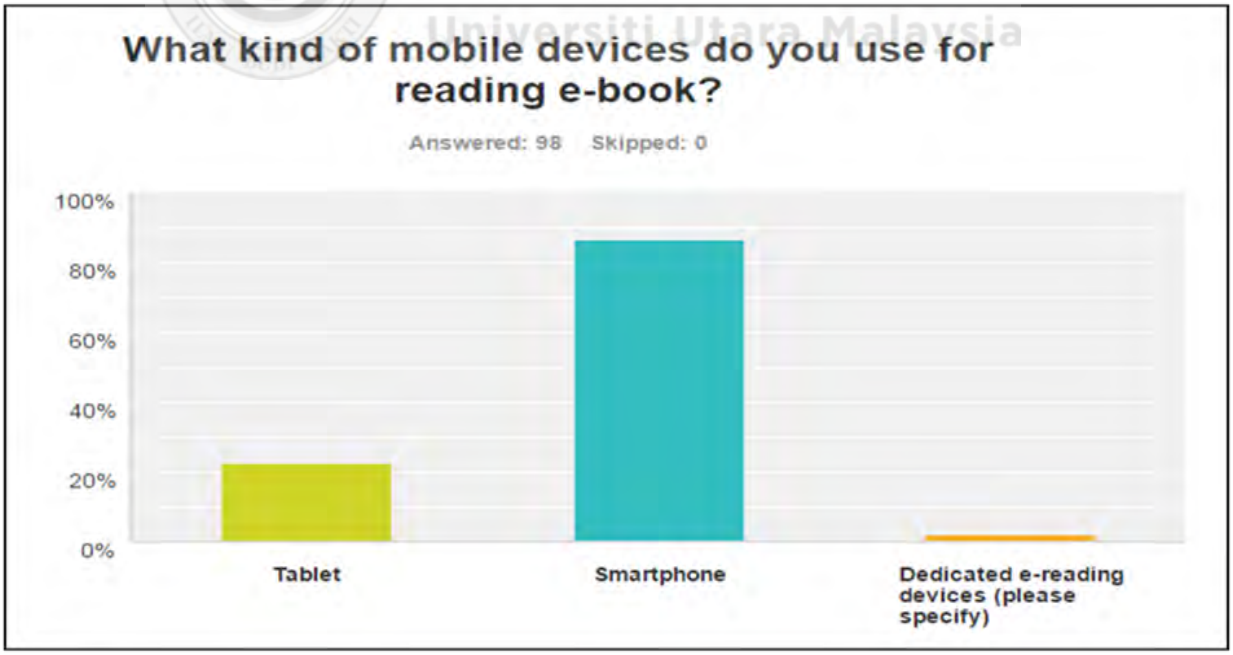
Pilot Study Results

Pilot study (survey) results to identify the most widely used applications to read e-book, and the most widely used platform and mobile devices for this purpose.

The survey result shows that the three most widely used e-book applications in Android platform are Adobe Acrobat Reader, Ebook Reader, and Amazon Kindle







Appendix B

Questionnaire

In this appendix, the study presents the initial design of the questionnaire developed in this study. The goal from this questionnaire is to collect subjective satisfaction data regarding the usability of three e-book applications from student's perspective.

Usability Evaluation model for mobile e-book applications

Dear participant,

I am a student doing my Master in Information Technology, School Of Computing, Univirsti Utara Malaysia. I am conducting a study on the usability of mobile applications. This study aims to design a model for evaluating the usability of mobile e-book applications from student's perspective. This study is important to address the current usability issues in e-book applications. Therefore, I would like to ask you to perform some tasks as listed below and after finishing the tasks, please fill out the questionnaires.

Your answer plays a significant role in the success of this study and you are assured that such will be treated with utmost confidentiality.

Note:

If you face any difficulties in performing the task, feel free to ask for help.

Task Scenario 1:

You are now in the first page of the document; try to:

T1: find the table of content which will give you clear information about the main content of the document as well as facilitate navigating the book.

Task Scenario 2:

One of the important tools for navigating the book content is the search tool; try to:

T2: locate the search icon.

Task Scenario 3:

In the academic reading, readers usually highlight, bookmark, copy, and take notes when they read. Readers also need to define some terms. These are important activities that increase their Readability and as a result their Understandability. Try to:

T3: Bookmark the first page

T4: Highlights a paragraph

T5: Copy text

T6: Take note in the first page

T7: Select a word and translate or define this word within the application

Task Scenario 4:

You already make some annotation in the book (bookmarks, highlights, and notes), try to:

T8: Locate them and share these annotations with other applications

T9: Delete these annotations

Task Scenario 5:

You are reading in a small screen, the text seem to be not readable in this screen size. Try to:

T10: Change the font size to suit your needs

T11: Set your preference font style and line spacing

T12: Change to night theme

Task Scenario 6:

Books usually consist of so many pages. If you read paper book, you turn the pages forward and backward as well as you can go directly to a specific page. Electronically, you can do this also as well as scrolling the pages. Try to:

T13: Turn pages. if the pages not turned, can you set the application setting to support that

T14: Go directly to a specific page number from where you are

Task Scenario 7:

You have some vision issues and you need to listen instead of read. Try to:

T15: activate the reading mode (read aloud) or open an audio book.

Kindly answer the questions in the next pages.

SECTION A: PARTICIPANT'S PROFILE

Please choose the appropriate answer:

1. **Gender:** ☐ Male ☐ Female

2. **Age**:

☐ Less than 21 years

☐ 21-30 years

☐ 31-40 years

☐ More than 40 years

3. **Current educational level:**

☐ Bachelor degree ☐ Master degree ☐ Doctoral degree

4. **Mobile experience:**

How long have you been used	Never	*< 1 year*	*1-3 years*	*>3 years*
Mobile applications (games, chatting apps, banking apps, etc)				
E-book applications (PDF viewer, mobile office apps, etc)				

Next page…

SECTION B: SATISFACTION QUESTIONNAIRES

The following questionnaires aim to evaluate the usability of the e-book applications from student's perspective. Please select the most appropriate rating scale number from 1 to 5 as the following:

Not at all satisfied = 1; Slightly satisfied =2; Moderately satisfied = 3; Very satisfied = 4; Completely satisfied =5

No	Characteristics	Questions	1	2	3	4	5
1	Readability	The application provide features to change text format (size, style, color)					
2		The application allows me to change line spacing					
3		The application provide a dictionary or encyclopedias					
4		The application allow me take notes					
5		The application allow me bookmark the pages					
6		The application allow me take hand writing notes					
7		The application allow me highlight text					
8		The application support magnification (zoom in/zoom out)					
9	Effectiveness	I can share my bookmarking and annotations with other applications and social networks					
10		The application provide an intelligent search tool					
11		The application provide a separate view of the list of bookmarking and annotations					
12		I am able to delete my bookmarking and annotations					
13		I can copy text					
14		The application provide print function					
15		I can read my books offline					
16		I can change Background color					
17		The application providing a clear, direct, and permanent navigation tools and annotations in all pages					
18		The setup procedure is very easy					

Not at all satisfied = 1; Slightly satisfied =2; Moderately satisfied = 3; Very satisfied = 4; Completely satisfied =5

No	Factor	Questions	1	2	3	4	5
19	Effectiveness	I can easily download books					
20		I can share my books with others					
21		The application support add more than one bookmarking per page					
22		Main menu and icons are standard and clearly represent their function					
23		The notes are visually viewed in the pages					
24		The application support take audio notes					
25		The page is reflowed to suit the device screen size					
26	Accessibility	The application support text to speech/read mode					
27		The application support open audio books					
28		The application views content in a suitable font size with the ability to change font size					
29		The application permits read text in horizontal orientation					
30	Efficiency	I can complete tasks in an acceptable time					
31		I can complete a task easily with minimum number of taps					
32	Navigation	The application provide hypertext table of content					
33		The application provide pagination (page number)					
34		The application provide a navigation bar					
35		The application provide search tool					
36		The application provide jump to specific page					
37		I can navigate the book by turning page					

THANK YOU VERY MUCH

Appendix C

New Reliability for Each Question

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
R1	114.67	184.989	.341	.844
R2	115.67	183.057	.334	.845
R3	115.63	177.964	.418	.842
R4	113.93	192.271	.368	.843
R5	113.93	191.789	.339	.844
R7	113.83	192.075	.374	.843
R8	113.77	193.978	.300	.845
EFV1	115.10	180.024	.430	.841
EFV2	114.53	182.947	.490	.839
EFV3	114.50	193.983	.179	.847
EFV4	114.00	195.379	.187	.847
EFV5	114.43	186.116	.295	.846
EFV6	116.07	179.099	.461	.840
EFV7	114.37	192.033	.209	.847
EFV9	114.33	188.989	.493	.841
EFV10	114.53	187.637	.386	.842
EFV11	114.53	189.430	.458	.841
EFV12	114.10	192.024	.350	.844
EFV13	115.23	178.185	.500	.838
EFV14	114.17	192.006	.299	.844
EFV15	114.27	185.789	.502	.839
EFV16	116.43	187.909	.307	.845
EFV17	114.23	193.978	.258	.845
ACC1	116.10	188.576	.247	.847
ACC2	116.47	187.637	.322	.844
EFC1	114.40	190.386	.458	.842
EFC2	114.47	188.326	.501	.840
NAV1	114.23	188.737	.494	.840
NAV2	113.97	191.964	.388	.843
NAV3	114.43	184.599	.423	.841
NAV4	113.93	191.099	.399	.843
NAV6	114.07	191.099	.364	.843

Appendix D

Outliers

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.0546	4.3353	3.5000	.51860	30
Std. Predicted Value	-2.787-	1.611	.000	1.000	30
Standard Error of Predicted Value	.068	.168	.116	.028	30
Adjusted Predicted Value	2.0888	4.4036	3.5120	.52097	30
Residual	-.47758-	.49197	.00000	.24215	30
Std. Residual	-1.794-	1.848	.000	.910	30
Stud. Residual	-2.027-	1.911	-.020-	1.003	30
Deleted Residual	-.60940-	.52606	-.01200-	.29589	30
Stud. Deleted Residual	-2.179-	2.032	-.021-	1.036	30
Mahal. Distance	**.913**	**10.639**	4.833	2.838	30
Cook's Distance	.000	.189	.037	.047	30
Centered Leverage Value	.031	.367	.167	.098	30

a. Dependent Variable: SATISFACTION

Appendix E

Multicollinearity

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.361-	.403		-.896-	.379		
	READABILITY	.121	.077	.161	1.565	.131	.708	1.412
	EFFECTIVENESS	.253	.101	.271	2.498	.020	.632	1.582
	ACCESSIBILITY	.225	.045	.477	4.950	.000	.803	1.246
	EFFICIENCY	.165	.090	.200	1.837	.079	.630	1.586
	NAVIGATION	.316	.087	.366	3.633	.001	.733	1.364

a. Dependent Variable: SATISFACTION

Appendix F

Normality

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Participant gender	30	1.43	.504	.283	.427	-2.062-	.833
Participant age	30	2.63	.718	.094	.427	-.189-	.833
Participant educational level	30	2.43	.679	-.805-	.427	-.402-	.833
mobile applications experience	30	3.57	.728	-1.971-	.427	4.361	.833
Ebook applications experience	30	3.17	1.053	-1.114-	.427	.079	.833
R1	30	3.67	1.373	-.888-	.427	-.350-	.833
R2	30	2.67	1.561	.250	.427	-1.531-	.833
R3	30	2.70	1.685	.277	.427	-1.697-	.833
R4	30	4.40	.675	-.693-	.427	-.517-	.833
R5	30	4.40	.770	-1.339-	.427	1.874	.833
R7	30	4.50	.682	-1.047-	.427	-.034-	.833
R8	30	4.57	.626	-1.172-	.427	.431	.833
EFV1	30	3.23	1.501	-.296-	.427	-1.343-	.833
EFV2	30	3.80	1.157	-1.014-	.427	.565	.833
EFV3	30	3.83	.950	-.680-	.427	1.044	.833
EFV4	30	4.33	.711	-.594-	.427	-.758-	.833
EFV5	30	3.90	1.423	-1.198-	.427	.081	.833
EFV6	30	2.27	1.484	.795	.427	-.822-	.833
EFV7	30	3.97	1.098	-.935-	.427	.348	.833
EFV9	30	4.00	.743	-.541-	.427	.565	.833
EFV10	30	3.80	1.031	-.786-	.427	.496	.833
EFV11	30	3.80	.761	.362	.427	-1.141-	.833
EFV12	30	4.23	.728	-.396-	.427	-.957-	.833
EFV13	30	3.10	1.447	-.113-	.427	-1.236-	.833
EFV14	30	4.17	.834	-.715-	.427	-.083-	.833
EFV15	30	4.07	.944	-1.192-	.427	2.238	.833
EFV16	30	1.90	1.213	.948	.427	-.779-	.833
EFV17	30	4.10	.712	-.762-	.427	1.465	.833
ACC1	30	2.23	1.357	.522	.427	-1.326-	.833

ACC2	30	1.87	1.196	.922	.427	-.841-	.833
EFC1	30	3.93	.691	.087	.427	-.770-	.833
EFC2	30	3.87	.776	.242	.427	-1.261-	.833
NAV1	30	4.10	.759	-.680-	.427	.655	.833
NAV2	30	4.37	.669	-1.327-	.427	3.824	.833
NAV3	30	3.90	1.185	-1.261-	.427	.881	.833
NAV4	30	4.40	.724	-1.379-	.427	2.730	.833
NAV6	30	4.27	.785	-.983-	.427	.903	.833
Valid N (listwise)	30						

Appendix G

Correlations

		READABILITY	EFFECTIVENESS	ACCESSIBILITT	EFFICIENCY	NAVIGATION	SATISFACTION
READABILITY	Pearson Correlation	1	.362*	.348	.276	.315	.595**
	Sig. (2-tailed)		.049	.059	.140	.090	.001
	N	30	30	30	30	30	30
EFFECTIVENESS	Pearson Correlation	.362*	1	.143	.546**	.354	.637**
	Sig. (2-tailed)	.049		.450	.002	.055	.000
	N	30	30	30	30	30	30
ACCESSIBILITT	Pearson Correlation	.348	.143	1	-.049-	-.111-	.521**
	Sig. (2-tailed)	.059	.450		.796	.558	.003
	N	30	30	30	30	30	30
EFFICIENCY	Pearson Correlation	.276	.546**	-.049-	1	.420*	.523**
	Sig. (2-tailed)	.140	.002	.796		.021	.003
	N	30	30	30	30	30	30
NAVIGATION	Pearson Correlation	.315	.354	-.111-	.420*	1	.544**
	Sig. (2-tailed)	.090	.055	.558	.021		.002
	N	30	30	30	30	30	30
SATISFACTION	Pearson Correlation	.595**	.637**	.521**	.523**	.544**	1
	Sig. (2-tailed)	.001	.000	.003	.003	.002	
	N	30	30	30	30	30	30

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Appendix H

Regression Results

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.906[a]	.821	.784	.26619	.821	22.015	5	24	.000

a. Predictors: (Constant), NAVIGATION, ACCESSIBILITT, EFFECTIVENESS, READABILITY, EFFICIENCY

b. Dependent Variable: SATISFACTION

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.799	5	1.560	22.015	.000[b]
	Residual	1.701	24	.071		
	Total	9.500	29			

a. Dependent Variable: SATISFACTION

b. Predictors: (Constant), NAVIGATION, ACCESSIBILITT, EFFECTIVENESS, READABILITY, EFFICIENCY

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.361-	.403		-.896-	.379
	READABILITY	.121	.077	.161	1.565	.131
	EFFECTIVENESS	.253	.101	.271	2.498	.020
	ACCESSIBILITT	.225	.045	.477	4.950	.000
	EFFICIENCY	.165	.090	.200	1.837	.079
	NAVIGATION	.316	.087	.366	3.633	.001

Appendix I

Overall Satisfaction Results

Descriptives

Application Name				Statistic	Std. Error
Adobe Acrobat Reader	SATISFACTION	Mean		3.3480	.08854
		95% Confidence Interval for Mean	Lower Bound	3.1477	
			Upper Bound	3.5482	
		5% Trimmed Mean		3.3458	
		Median		3.3677	
		Variance		.078	
		Std. Deviation		.27998	
		Minimum		2.96	
		Maximum		3.77	
		Range		.81	
		Interquartile Range		.57	
		Skewness		-.050-	.687
		Kurtosis		-1.196-	1.334
Ebook Reader	SATISFACTION	Mean		3.3739	.15176
		95% Confidence Interval for Mean	Lower Bound	3.0306	
			Upper Bound	3.7172	
		5% Trimmed Mean		3.3974	
		Median		3.4346	
		Variance		.230	
		Std. Deviation		.47991	
		Minimum		2.45	
		Maximum		3.87	
		Range		1.42	
		Interquartile Range		.69	
		Skewness		-.702-	.687
		Kurtosis		-.454-	1.334
Amazone Kindle	SATISFACTION	Mean		3.8716	.12983

	95% Confidence Interval for Mean	Lower Bound	3.5779	
		Upper Bound	4.1653	
	5% Trimmed Mean		3.8834	
	Median		4.0196	
	Variance		.169	
	Std. Deviation		.41055	
	Minimum		3.16	
	Maximum		4.38	
	Range		1.22	
	Interquartile Range		.65	
	Skewness		-.616-	.687
	Kurtosis		-.919-	1.334